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FIRE CONTROL NOTES

FALL 1972 • VOL. 33, NO. 4

U.S. DEPARTMENT OF AGRICULTURE • FOREST SERVICE



FIRE CONTROL NOTES

An international quarterly periodical devoted to forest fire control

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DeHaviland Beaver Succeeds As Land-Based Air-Tanker

R. W. Johansen and H. K. Mikell

In 1968 the Florida Division of Forestry outfitted a single-engine, land-based DeHaviland Beaver with a 300-gallon-capacity, interior-mounted tank for dropping ammonium phosphate solutions on wildfires in Florida. The DeHaviland Beaver aircraft has been used as a float-plane water tanker for years in Canada with the drop tanks incorporated in the floats.

Modification Made

Before the plane could fly the following structural modifications were made to the aircraft

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H. K. Mikell is assistant director, Division of Forestry, Florida Department of Agriculture and Consumer Services, Tallahassee, Fla.*

to make room for the tank opening and to compensate for load and additional stresses:

1. Removal of the center fuel tank.
2. Rerouting of the fuel and electrical systems.
3. Removal of the skin and stringers on the underside of the fuselage for an opening 22 inches long and 31 inches wide below the position of the removed fuel tank.
4. Stressing the skin of the aircraft by use of double plate and external stringers to retain the originally designed strength.
5. Replacing the wing-lift struts with C2W115-1 and C2W115-2 struts as per DeHaviland Service Bulletin 2/3 dated 12/30/67. Special release gates that provided an opening of 550 square inches were designed for the tank bottom.

Most of the materials used in the construction of the tank itself were Federal excess prop-

erty items, and accurate cost records are not available. Approximately 20 man days' labor were involved. Florida's second Beaver was converted into a tanker the summer of 1971.

Plastic Cup Tests Conducted

Calibration tests were conducted, with the use of Southern Forest Fire Laboratory equipment, to ascertain the distribution pattern of liquids dropped from this tanker at altitudes of 75 to 100 feet. A grid system of 1/2-gallon plastic cups was laid out on the ground, and drops were made immediately above the grid. Water was used as the drop material since it closely approximated the drop characteristics of the ammonium phosphate solutions to be used in Florida.

During the drop period the relative humidity ranged between 33 and 60 percent, and a crosswind ranging between 8



Pilot reports on the Beaver's performance are enthusiastic . . .

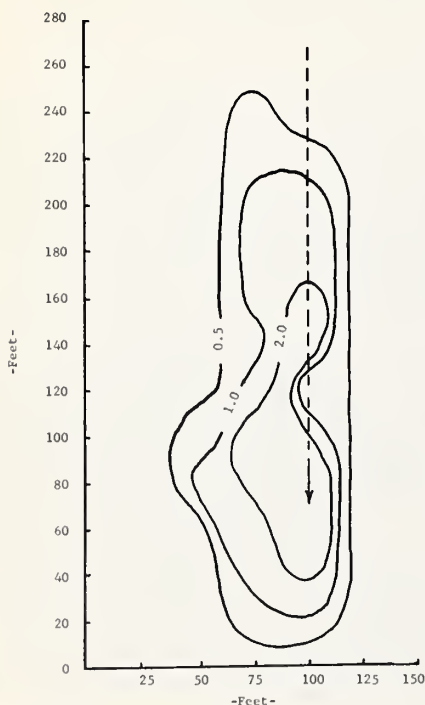
and 13 miles per hour persisted at the drop zone. The air tanker altitude at the time of load release was about 75 feet.

DeHaviland Drops Compare Well

The amount of liquid caught in each cup was weighed on a balance, converted to terms of gallons per 100 square feet, and recorded on a sheet representing the drop zone. All of the drops were comparable to the one shown.

While liquid was found to

DeHaviland Beaver tanker drop pattern (No. 4) with lines and numbers showing minimum application rates in gallons per 100 square feet. Arrow indicates flight direction.



spread over a distance of at least 350 feet in the drop grid, some of the area covered was in amounts too little to be considered effective. The lightest effective application rate in our lighter fuels in the Southeastern States is $\frac{1}{2}$ gallon per 100 square feet. In heavier fuels at least 1 gallon is needed. Drop lengths in terms of these two minimum application rates ranged from 240 to 300 feet at the $\frac{1}{2}$ -gallon minimum and 200 to 280 feet at the 1-gallon rate (table). Drop width at the $\frac{1}{2}$ -gallon minimum ranged from 50 to 60 feet and only slightly less at 1 gallon. Over 80 percent of the material leaving the aircraft was accounted for in the cups in four of the five drops. In one drop only, 70 percent of the material was accountable.

The DeHaviland Beaver drops had good conformation and could be compared favorably with drops of comparable volumes from other aircraft, such as TBM's.

Tankers Were Successful

Florida's 1969 fire season was the best in a decade; consequently, only 16 drops on 7 fires were made. Only one drop, made directly into a hot head fire in heavy fuel, was unsuccessful. The winter of 1970-71 proved to be a disastrous fire year in Florida. The Beaver tanker made 64 drops during the fire year, all of which were considered successful.

A small wildfire in heavy fuel north of Naples, Fla., was contained by the use of the Beaver alone until ground equipment could reach the area for mopup. If this fire had escaped, the Corkscrew Wildlife Sanctuary with its unique flora and fauna would have suffered immeasurable damage.

Pilot reports on the Beaver's performance are enthusiastic but are something less than this with regard to speed and comfort. A pilot should have agricultural spraying experience, at least 500 hours at low altitudes with heavy loads, prior to operating a Beaver tanker. Δ

Drop pattern, Florida Forest Service, 300-gallon DeHaviland Beaver Tanker

Drop Number	Load Size	Pattern Length	
		Exceeding $\frac{1}{2}$ gal./100 ft. ²	Exceeding 1 gal./100 ft. ²
	Gallons	Feet	Feet
1	250	240	240
2	250	260	240
3	250	260	220
4	300	240	200
5	300	300	280



Fire Simulator Room Supplements Classroom Teaching

Hershel C. Reeves and Don A. Clymer

Recognizing the growing role of simulators in the training of fire control personnel, Stephen F. Austin State University installed fire simulation equipment in its forestry building. Although designed primarily to familiarize forest managers with this specialized training aid, it shows promise as a supplement to classroom teaching.

The installation includes a portable Scott "Dynamic Situation Simulator" built to Forest Service, USDA specifications but with a specially designed sound system; an educational communication system with trainee positions; an Osborne Fire Finder; a dispatcher's wall map; and supplemental devices.

Simulator 'Opens Eyes'

Fire simulators have been used by protection agencies almost exclusively in training for the correction of specific problems among experienced fire con-

trol personnel. At Stephen F. Austin State University, however, the simulator is used to reinforce and supplement classroom courses on fire control. Exercises are relatively simple and emphasize fire size-up, initial attack, coordination of equipment and manpower, setting priorities, and dealing with emerging problems. The simulator is operated by faculty and students who prepare and present the exercises for students in the fire class each semester. The fire simulator gives the students a chance to gain an insight into the complexities of fire behavior and suppression prior to actual field experience.

The fire finder can be used in conjunction with the fire simulator for lookout training.¹ While fixed lookout towers are decreasing in number due to the increase in aerial detection, the use of fire-finders, such as the Osborne, will continue to be stressed at Stephen F. Austin State University for the near future.

5 Projectors Used

The Dynamic Situation Simulator integrates four overhead

projectors into a single unit.² Fire and smoke are simulated by scribing on opaqued glass plates on two of the projectors. Movement of fire and smoke is indicated by manipulating motorized perforated discs located inside the projectors. Background scenery is provided by duplicate transparencies on the remaining two projectors. Fire char and changes in smoke can be added on special plates above the background transparencies. An additional projector permits simulation of fire lines or other detail by scribing.

The stereo sound effects are made by a portable recording unit providing for transfer of sound between reel-to-reel and cassette tape and by either reel-to-reel or cassette recording from an external source. Additional sound recording is provided by a 2-track monaural cassette recorder, which may be

¹ Burnaugh, J. A. and I. T. Kittell, 1969. Fire simulation livens lookout training. *Fire Control Notes* 20(4): 3-4.

² Specifications are available from Scott-Engineering Sciences, 1400 S.W. 8th St., Pompano Beach, Florida 33060. See also Ball, H. E. 1971. New compact simulator provides new versatility. *Fire Control Notes* 32(3): 7-8.

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The fire simulator room is adaptable to many problems . . .

operated by battery for recording sound effects in the field.

Simulator sounds are played from reel-to-reel or cassette tapes into six 8-inch dual-voice-coil wall-mounted speakers. The speakers are wired so that each will operate on either the monaural public address system, the stereo sound effects system, or both simultaneously, as selected at the control center. During the simulation exercise the recorders are operated to provide three different, simultaneous sound effects by adjusting volume controls. Additional sound effects are produced by changing cassettes during the exercise.

Equipment Versatile

The educational communication system can be used alone or in conjunction with fire simulation. It affords 2-way vocal communication between the instructor and class members and from student to instructor by a responder, transmitting a choice of answers to specific questions. At the instructor's console, four pointer dials indicate simultaneously the percentage of students selecting each of four (or fewer) choices on any multiple-choice question. A light panel indicates each student's choice. In addition, the scores of individual students can be accumulated on counters, so questions can be weighted in value if so desired.

Other equipment available for use in the overall communication system includes microphones and earphones for each student and headphone sets for supervisory personnel. Each student desk has a telephone which can be used to call the control

booth. Instructional personnel can ring all student phones simultaneously or individually.

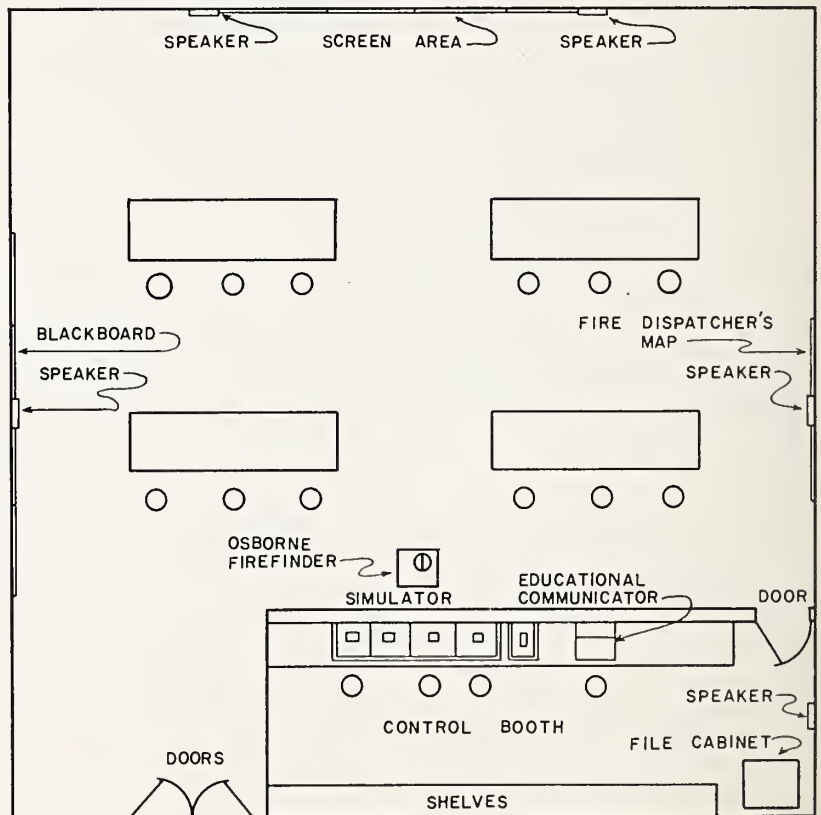
Telephone and microphone conversations can be amplified through the wall speaker system, and tape recorded, if desired, for later reference in debriefing sessions.

Room Has Many Uses

The fire simulator room and its equipment is adaptable to problems in watershed management (especially flood control), recreation planning, civil engi-

neering (forest road construction), and law enforcement. The educational communicator permits use of modern teaching methods, including instant response testing of student comprehension, and seminar-type discussions based upon projected visual aids. The combination of learning and teaching facilities in the Stephen F. Austin State University simulator room provides the student valuable supplements to classroom instruction. 

Interior arrangement of Fire Simulator Room, School of Forestry, Stephen F. Austin State University.



Hydraulic Seeder Sprays Retardants

Franklin R. Ward and
John D. Dell

A commercially available hydraulic seeder was tested for the mixing and ground application of fire retardants. It is normally used for mixing and spraying water, seed, and fertilizer along with other soil stabilization materials. Powdered and liquid retardants were satisfactorily mixed and sprayed with the seeder on roadside vegetation.

Early Sprayers Used

Use of fire retardants for wildfire and prescribed burning has increased the demand for application of this material with ground tankers. Several types of equipment have been designed or adapted for this purpose. In 1963, the San Dimas Equipment Development Center reported on a specially designed tanker-mixer slip-on unit.¹

A few years later, Region 6 successfully field-tested a small

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compact trailer-mounted retardant mixer.² More recently, the Missoula Equipment Development Center contracted for a high-volume retardant sprayer custom-assembled from stock components.³ This unit was tested for perimeter treatment on a number of prescribed burns in Regions 1, 5, and 6.

Seeder Used

In 1970, the Pacific Northwest Region decided to test a commercially available hydraulic seeder that is used regularly by the Oregon State Highway Department for roadside maintenance (fig. 1). Normally, the State uses this equipment as a mixer and sprayer for application of water, seed, and fertilizers together with limestone and/or other materials (such as wood cellulose) for soil stabilization alongside highways and roads. We found it very satisfactory for mixing and applying any of the powdered or liquid fire retardants normally used for pretreatment of prescribed burn areas.

In a test conducted on forest roadsides in the Williamette

Figure 1. The hydraulic seeder can be used effectively for application of fire retardants before and during prescribed burning operations.

National Forest, it took only 8 minutes to cover understory vegetation on a strip 1,000 feet long and 30 feet wide. A total of 700 gallons was used at a rate of 2.33 gallons per 100 square feet. On a second strip (600 feet long and 30 feet wide), 500 gallons (2.77 gallons per 100 square feet) were applied in 6½ minutes. Aerial and ground fuels were adequately covered in both cases.

The unit was also tested for spraying hard-to-reach vegetation on top of steep cutbanks above areas (fig. 2), where fire spotting might occur during

¹ Arcadia Equipment Development center. A new ground chemical tanker-mixer for forest fire fighting. *Fire Contr. Notes* 24(1): 17-19, illus., 1963.

² Franklin R. Ward, John D. Dell, and William C. Wood. New trailer-mounted fire retardant mixer successfully field-tested. *Fire Contr. Notes* 29(3): 15, illus., 1968.

³ Arthur H. Jukkala. High-volume retardant sprayer. *Fire Contr. Notes* 30(1): 4, illus., 1969.



Figure 2. The hydraulic seeder can also be used to treat fuels on high cutbanks above cutover areas.

burning operations. Although this required more time and care in application, these fuels received adequate coverage.

The equipment used was a Finn Super 1000 Hydroseeder Model HSUSX manufactured by the Finn Equipment Company of Cincinnati, Ohio. There are however, other manufacturers producing similar equipment which we did not investigate. The Hydroseeder was capable of pumping 180 gallons per minute at 110 pounds per square inch with a variable discharge distance from 20 to 200 feet. The pump and nozzle clearances were able to pass solid material up to 1 inch in diameter. The retardant is mixed by a paddle type agitator that works in conjunction with recirculation.

Deck Gun Delivers

A favorable feature of the equipment is its "deck gun" discharge assembly. The nozzle for this deck gun is mounted on a stand on top of the tank and is

capable of 360 degree horizontal rotation and 120-degree vertical travel. Six quick-coupling nozzles are available, varying from fine spray to straight stream (fig. 3). The hose fitting is also quick-coupling. There is a 1½-inch outlet for using a hose on hard-to-reach areas. The tank has a 1,000-gallon capacity and is coated with an epoxy substance which prevents corrosion. It has a 400-square-inch top opening including a bag cutter. The model we tested has a 57-horsepower water-cooled engine with electric starter, generator, battery, air cleaner, muffler, and clutch. It is also available with a 56-horsepower air-cooled engine. It is not capable of drafting, but it can be filled by hydrant or portable pump. The approximate weight of the entire slip-on unit is 4,300 pounds. This Hydroseeder cost about \$5,300 (1969 prices) and is delivered complete, ready for operation.

The Oregon State Highway

Department has used its unit almost constantly for over 7 years. They report that it has held up extremely well with normal maintenance.

Our tests show this equipment is suitable for retardant application on prescribed burns in Northwest forest areas. Also, it is multifunctional, being suitable for slope stabilization, seeding, fertilizing, and wildlife control operations. 

Figure 3. Quick-coupling nozzle tips ranging from straight stream to a fine spray are available.



Hand Labor Is the Key To Fire Fighting

Jim Casey

Maybe some day industry will come up with a machine that can crawl around a smoke-filled apartment looking under beds and opening closets. Maybe some day industry will come up with a machine that will be able to climb an 85-foot aerial and hand-wrestle a hysterical or semi-conscious woman out of a top-floor window. Maybe, too, there will be an automated gadget that can take a hose line up a twisting stairway, free the ... [couplings] that get stuck at the turns, force a door and then open the nozzle on the fire. Maybe this will all come about, but we doubt it.

Like the infantryman's the fire fighter's job will always involve "hand labor." You just can't get along without it.

We often hear that 10 men with a hoe have been replaced by one tractor-drawn cultivator and "why can't this technology be applied to the fire service?" However, [as] in the garment industry, the hallmark of quality is still the label "hand-made." It's expensive but it's good.

Good fire protection is also expensive because it, too, is hand labor. On top of this, it requires intelligence, skill, and courage. Why should our communities settle for anything less? Δ

Jim Casey is editor, Fire Engineering.

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Fire fighters may need to rest, but their pulaskis are always ready.



'Big Ed's' Pulaski Still Going Strong

Each year the Forest Service and other agencies purchase about 25,000 pulaskis from GSA at a total cost of about \$138,000.

The pulaski fire tool, half mattock and half axe—a basic weapon of the fire-fighter—is the product of an early ranger, Edward C. "Big Ed" Pulaski, who distinguished himself in the great Idaho forest fire of 1910.¹ He saved the lives of his crew by leading them to the safety of an old mine tunnel while the blaze swept over, and in the process lost most of his eyesight. He was the descendant of the Polish commander Casimir Pulaski, a hero of the American Revolution.

While essentially the same tool as before, the pulaski's specifications were revised just last year. This valuable tool now boasts better steel, handles, and bonding.

'Big Ed' would be proud. Δ

¹ In the August 1910 fire, 85 persons lost their lives, 74 of them fire-fighters. Several towns and nearly 3 million acres of forest were destroyed.

Yarding Spar

Stores Water



With a few adjustments, the hollow steel spar of a yarder machine can double as a water tank.

MacMillian Bloedel Limited, British Columbia, stores a minimum of 500 gallons of water at each logging site for initial attack on an operational fire during the fire season. This water storage takes a number of different forms, ranging from natural streams or pools, trailer mounted tanks, tank trucks, and, since the advent of the hollow steel portable "spar tree," the spar itself.

Vents & Couplings Added

The spar is 27 inches in diameter and will hold 29.7 U.S. gal-

lons per lineal foot. The normal procedure is to seal off the spar 20 feet up from the base, install a threaded vent hole to the outside just below the 20-foot mark and to provide two 2-inch pipe couplings 3 inches above the base, one facing the machine and the other directly opposite. The outlet facing the machine is for the pump suction and the other to help flush and clean out if this becomes necessary.

The fire pump and hose are normally mounted on the yarder carrying the spar, near the spar base, and coupled to it by a valve and suction hose. The flexible hose allows the spar to be lowered for moving without disconnecting the pump. When the pump cannot be mounted near the base of the spar, the suction line is installed along the frame of the yarder to the pump location as is the case when a power take-off pump is used off the yarder engine. During a move the vent is normally plugged to prevent slop-spill.

Advantages Outnumber

As is the case in most innovations, some people like and use this water storage arrangement while others prefer to have tanker trucks at each site. The following are the advantages and disadvantages as expressed by operators.

Advantages:

1. There is no additional outlay for truck, trailer, or tank.
2. Water supply is always in the geographic center of the area

being logged by the yarder, whereas other forms of tankage may be up or down the road some distance due to the lack of space around the yarder and loader.

3. The tank is never left behind when the machine moves to a new location.
4. It does not add to the congestion around the yarder where space is always at a premium.
5. The pump takes suction under a positive head and thereby eliminates any priming problem.

Disadvantages:

1. The water supply is "tied-to" the machine, thus it cannot be moved to a fire outside the "setting."
2. The added weight of the water can sometimes be a problem when moving the yarder in steep terrain and also puts added strain on the spar raising equipment. Some operators drain the spar before lowering or moving which then necessitates refilling upon arrival at the new yarding site.
3. Confirming the water level in a spar tank is not as easy as in a tanker or trailer. A low calibrated pressure gauge could be used but workers consider it unreliable due to constant violent vibration of the yarder and spar, and they make a practice of topping up to the overflow weekly. Give your spars a long, hard look. Perhaps you can use this idea. 

Probability Makes Fire Danger Index More Reliable

Peter Kourtz

Fire danger index forecasting can reflect forecasting uncertainty by including ranges of probability for a given index. Including probability makes the index more reliable. Fire danger index forecasts are prepared by many Canadian fire control agencies (Nikleva, 1970; Paul, 1970; and Pouliot, 1968).

These forecasts are used for short-term presuppression planning, for instance, fire control manning levels, work plans, or detection strategy. Slash burns, the closing down of industrial operations, and the revocation of campfire and travel permits also may be based on such forecasts.

The general procedure for preparing an index forecast for an area is:

1. Calculate the *current index value* using yesterday's index values and today's weather. This calculation can be made using either index tables or equations.
2. Get a *local weather forecast*. This forecast must be in specific values, for example, relative humidity, 45 percent; temperature, 72 degrees F.; and wind speed 5 m.p.h.
3. Combine the current index values with the forecasted weather to obtain the *index forecast*.

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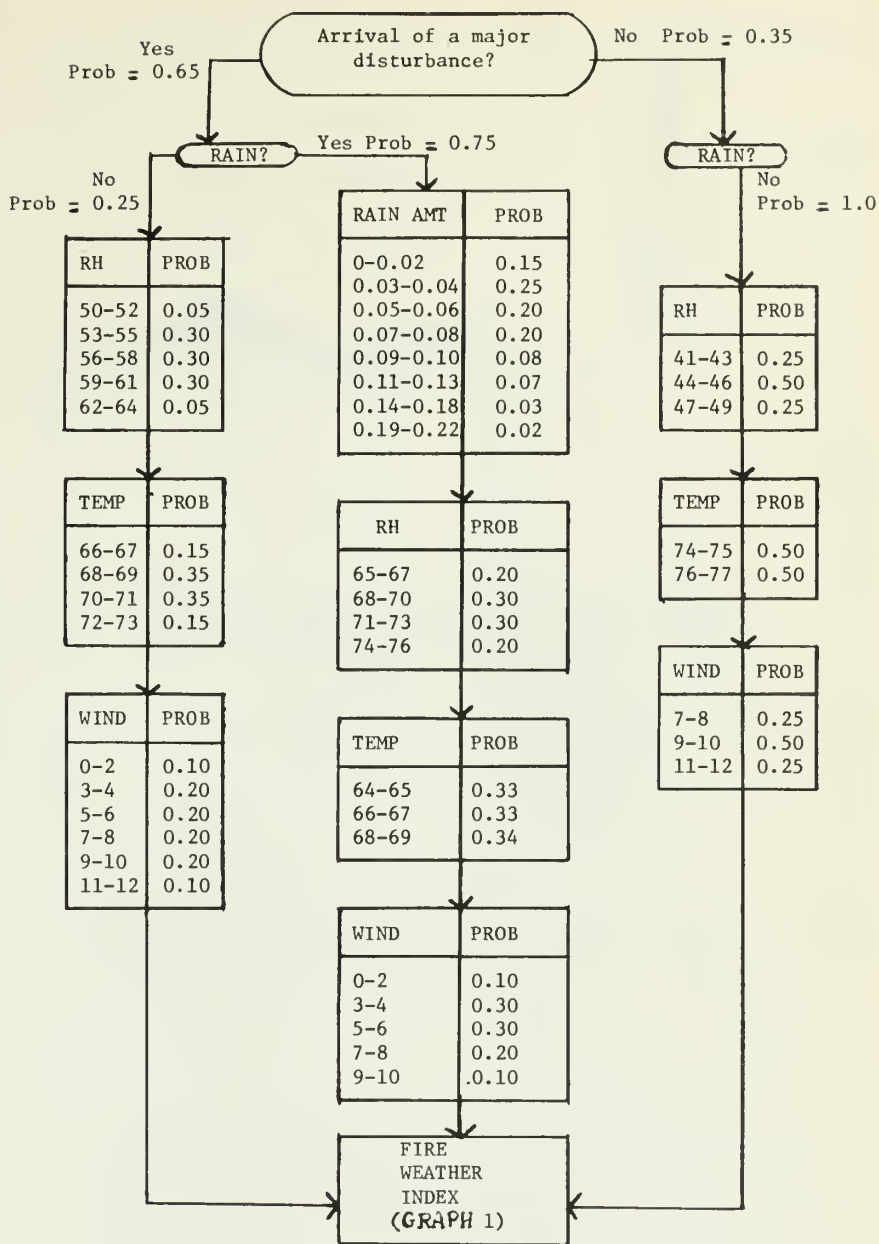
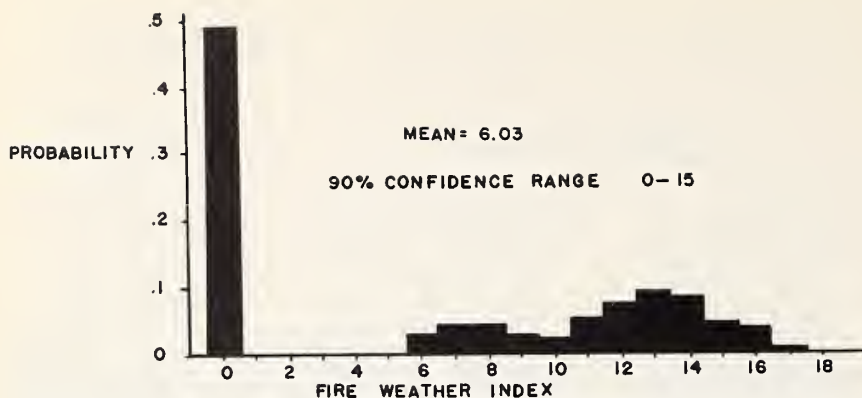


Chart 1.—An Uncertain Weather Situation (See graph 1)

It is becoming economically desirable to have an index forecast that can be relied upon for short-term planning. However, forecast reliability is less than it might be in the current forecasting scheme because weather can't be accurately predicted and because fire danger ratings are sensitive to small changes in wind speeds and precipitation amounts.

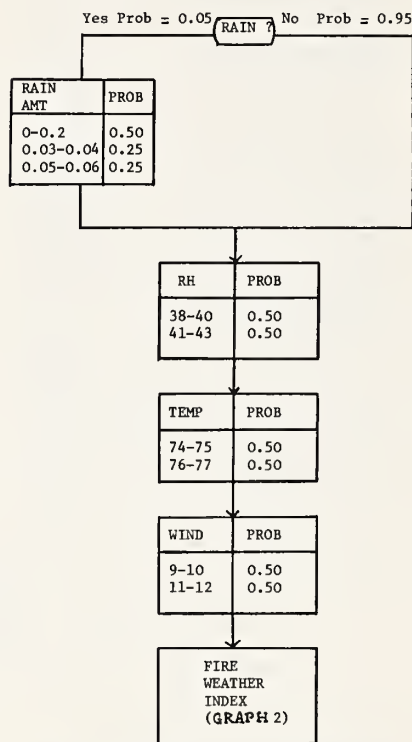
Incorporate Uncertainty

One possible approach to improving the forecast reliability is to incorporate the forecaster's uncertainty of his predictions into the index calculation. The result will be an index forecast in a range of probabilistic terms (see charts). An uncertain weather situation likely will result in a wide confidence range

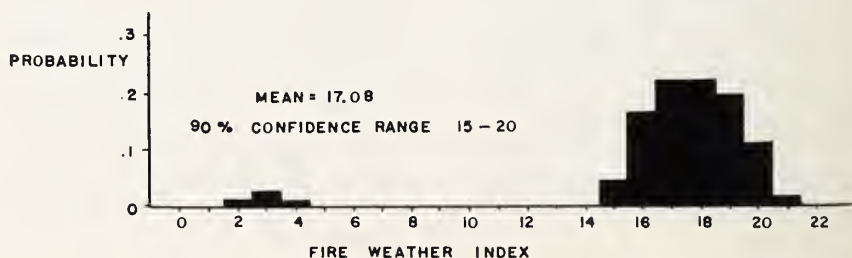


Graph 1.—Fire Weather Index Forecast Distribution for an Uncertain Weather Situation.

Chart 2.—A More Certain Weather Situation (See graph 2)



Graph 2.—Fire Weather Index Forecast Distribution for a More Certain Weather Situation.



(graph 1) for the forecasted index, an index into which little faith should be placed. An index forecast in which the forecaster has a great deal of confidence will have a narrow confidence range (graph 2).

The forecasted weather data for probabilistic fire danger forecasts would be in terms of *conditional, distinct probability distributions*.¹ For example, the forecaster might feel that the chance of rain tomorrow is about 1 in 3, or 33 percent, and furthermore, if it does rain, the amount of rain will have the following distribution:

Amount (inches)	Probability
0.00-0.05	0.50
0.06-0.10	0.40
0.11-0.20	0.10

Here, the forecaster is expecting only a light rain if it rains at all. Note that this method of presenting a forecast avoids the necessity of predicting specific values for weather events. This is a desirable feature of the method from both the forecasters' and users' viewpoints, especially during uncertain situations.

Computers Forecast

A small computer program

¹The Monte Carlo sampling technique (Hillier and Liebermann, 1965) provides the mechanism to combine the forecast distributions and today's indexes within the framework of the index calculation procedure. The result is a probability distribution for tomorrow's forecasted fire danger index.

has been written to demonstrate this method of forecasting. The charts present two sets of hypothetical forecast data. The resulting index distributions are presented in the graphs. The first example represents an uncertain forecast situation. The second example represents a reasonably certain forecast. The Canadian Forestry Service's Fire Weather Index system was used to make the index calculations.

Output for each forecast area could be reduced to three numbers—the upper 90 percent confidence limit, the lower 90 percent confidence limit, and the mean index value (see graphs).

Future fire danger forecasting schemes likely will be partially or even fully computerized. The addition of the probabilistic feature to the forecast will represent only a minor increase in the cost of such a system.

Forecasters with computers are capable of predicting in terms of distributions. But are these predictions reliable enough to justify their use? Δ

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'Zinger' Fire Prevention Slogan Needed

'I Can't Believe It Burned The Whole Thing!'

"We need a zinger," Richard E. Bland declared, "like 'I can't believe I ate the whole thing.' If a single slogan like that can make a man want to avoid a bellyache, we ought to be able to find a catchy one that will help keep him from burning to death."

Bland, appointed Chairman of the National Commission on Fire Prevention and Control by President Nixon last June,¹ posed the question at the opening session of the 76th Annual Meeting of the National Fire Protection Association (NFPA). Some 3,000 fire safety experts attended the week-long conference.

Is the public apathetic about fire or is fire of such personal consequence that concern is unconsciously suppressed?

Whatever the case, according to Bland, "It is absolutely necessary that we find a way to remove fire prevention from the 'ho hum' category exemplified by National Sandwich Week.

"In a society deluged visually and audibly with the cola generations, super time-saving detergents, and soft toilet tissue, you and I are going to have a hard time getting public attention by continuing to place posters on the firehouse door or the school bulletin board," he continued.△

¹ See: A Look at What Killed 12,000 People Last Year. *Fire Contr. Notes*, Spring 1972, 33(2): 20.

Pocket-size Fireline Handbook Off the Press

The new Forest Service *Fireline Handbook* is a ready reference to fire suppression principles, policies, and data.

It can be used to better:

1. Size up the job in relation to fuels, weather, and topography.
2. Plan the men, equipment, and facilities needed.
3. Organize and direct the job decisively and efficiently.

The *Fireline Handbook* is for sale for \$3 from the Superintendent of Documents, U. S. Government Printing Office, Washington, D. C. 20402—Stock number, 0101-0076.

The cover design is pictured here. △

FIRELINE HANDBOOK



UNITED STATES DEPARTMENT OF AGRICULTURE • FOREST SERVICE

Computers Help Plot Area-Seen Maps

Peter Kourtz and Shirley Nozaki

Computers can make the task of plotting area-seen maps easier and shorter by coordinating elevation data onto a grid centered on a predetermined lookout site.

First Maps Sketches

Area-seen maps of lookout coverage have been made since towers were first used to detect fires. Early maps consisted of sketches of the areas directly visible from potential or actual lookout locations. Later, survey instruments were used to pinpoint area-seen boundaries (Chorlton 1951). Two drawbacks of sketching were: 1) Many distances had to be estimated and, 2) only the areas directly visible could be mapped. Accuracy of distance estimates have been improved by the use of range finders, helicopters, and photography.

As topographic or contour maps became available for most forest regions, a profile technique was developed. This technique required the drafting of terrain profiles along lines radiating from the lookout location. Straight lines were projected from a proposed lookout location to identified terrain points. All points along the profile were classified visible or invisible, and

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the distances below line-of-sight could be calculated from the appropriate topographic map.

Profile Board Simplifies

Then the profile board method was developed to speed up mapping (Catto 1969). Point classification could be made without drafting profiles, and the board provided a simple procedure for correcting elevations for the earth's curvature (VanWagner 1965).

The most accurate area-seen maps to date have been made from within the lookout using a combination of the profile board and sketching methods.

A Computer Can Develop Area-Seen Map

Although the accuracy of a computer map is no better than one produced by the profile method, the computer can greatly simplify the task of making maps.

The computer program requires a uniformly-spaced grid of elevation points to be established over the area to be mapped. The lookout location is the center of the grid. The computer adjusts each elevation value for the effects of earth curvature and refraction.

A terrain profile is constructed from the lookout location to each elevation point in the grid. For a specific profile, a straight line is established between the grid point of interest and the lookout. Elevations along this line at all points where there is an intersection with a line of the grid are calculated using linear interpolation. Each profile consists of a vector of numbers where each element represents a function of the vertical angle from the lookout to a specific intersection point on the line. Once the profile vector is established, the distance below line-of-sight of the grid elevation

point is calculated in a manner similar to the profile method.

Data Input Required

The elevation values for this program may be obtained either manually from contour maps or from previously digitized topography data banks.

Computer tapes containing digitized elevation data for most of the forested area of the United States are available to Government agencies from the U.S. Department of Defense. Each tape contains data for one degree of latitude and longitude, the grid spacing for these points being about 210 feet. A special computer program is required to obtain a subset of these data.

Most of the terrain detail of Canada has not been digitized. There are available, however, excellent topographic maps for most of the forested regions of Canada.

The accuracy of the computer maps is dependent upon the density of grid points and the precision of elevation data. Although computer maps will not be as accurate as those produced by the sketch-profile board method, the total cost in man-hours and dollars to make a computer area-seen map is significantly less than to make a sketch-profile board map.

Additional information can be obtained from the authors, Forest Fire Research Institute, Canadian Forestry Service, Nicol Building, 331 Cooper Street, Ottawa, Ontario KIAOH3, Canada. 

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25th Anniversary of Holocausts Remembered

This article is excerpted from the testimony of Sen. Edward Muskie in the June 8, 1972, *Congressional Record*.

1972 marks the 25th anniversary of an event which resulted in passage of one of the most unique and significant pieces of forest fire protection legislation ever enacted in the history of our country.

The Northeastern Forest Fire Protection Compact, created by an act of Congress, was the first intergovernmental body of its kind and has served as a model of mutual aid for other sections of the country. Its establishment was a direct result of a series of disastrous forest fires which burned throughout New England and the Northeast during the autumn of 1947.

The events of 1947 pointed up the critical importance of interstate and Federal cooperation to deal effectively and promptly with forest fires. As a consequence, the 81st Congress on June 25, 1949, enacted Public Law 129 authorizing the Northeastern Forest Fire Protection Compact. Three years later on May 13, 1952, the 82nd Congress enacted Public Law 340 authorizing Canadian participation in the compact.



Within 4 months, [after enactment] six of seven specified member States had become party to a northeastern interstate forest fire protection compact. Rhode Island, whose legislature was not in session the previous year, became the seventh State by joining in 1950.

Although the Province of New Brunswick seriously considered becoming a member of the compact in the early 1950's, it was Quebec which was the first Canadian Province to become a

The Northeastern Forest Fire Protection Compact . . . has served as a model of mutual aid for other sections of the country.

member of the Northeastern Forest Fire Protection Compact on September 23, 1969.

Within a year, following "The Quebec Joinder," the Province of New Brunswick became a member of the Northeastern Forest Fire Protection Compact.

NFFPC Works

Mutual aid provisions of the compact were invoked for the first time in August of 1952 when extremely dry conditions and stubborn fires were affecting Maine, New Hampshire, Massachusetts, and Rhode Island. Arrangements were made through the Secretary and when calls for assistance resulted Vermont provided New Hampshire with pump operators and standby service. Maine received pumps and hose from New York in less than 5 hours from time of request.

The latest call for compact assistance came through the U. S. Forest Service in Washington for possible assistance of the Province of Ontario. Fifty thousand feet of hose and 23 portable pumps were made available for transport by military aircraft. Fortunately the situation cooled and dispatch was not necessary. 

¹ See *Fire Control Notes*, Summer 1970, 31(3): 9.



Smokey Figure, Fire Danger Adjectives Available For 1973 Campaign

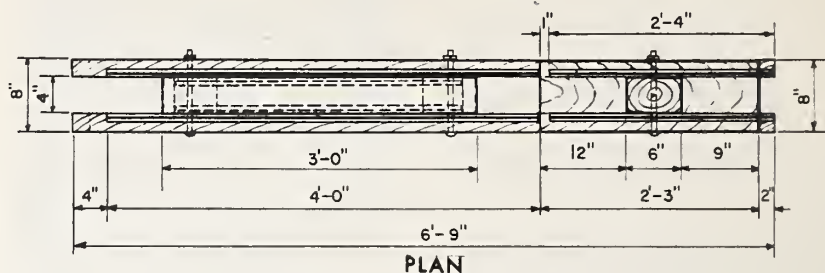
In "Smokey's 1973 Campaign" catalog are two prevention items you may wish to use: One is the Smokey bear figure and the other, a set of standardized fire danger adjectives. Both are designed to go on a sign you build that says "Fire Danger — Today, Prevent Forest Fires" (see cover).

This official rendition of Smokey is in color. It is adhesive-backed vinyl and comes left- or right-handed.

The five fire danger adjectives are also adhesive-backed vinyl and are color-coded and reflectorized. The colors are those accepted and used by most wildland fire protection agencies.

You can build the complete sign with the construction plans furnished with each order of fire danger adjectives.

To get the figure, adjectives, or both, contact your State forester or the Forest Service. Consult your "Smokey's 1973 Campaign" catalog for further information on these and other prevention items. 

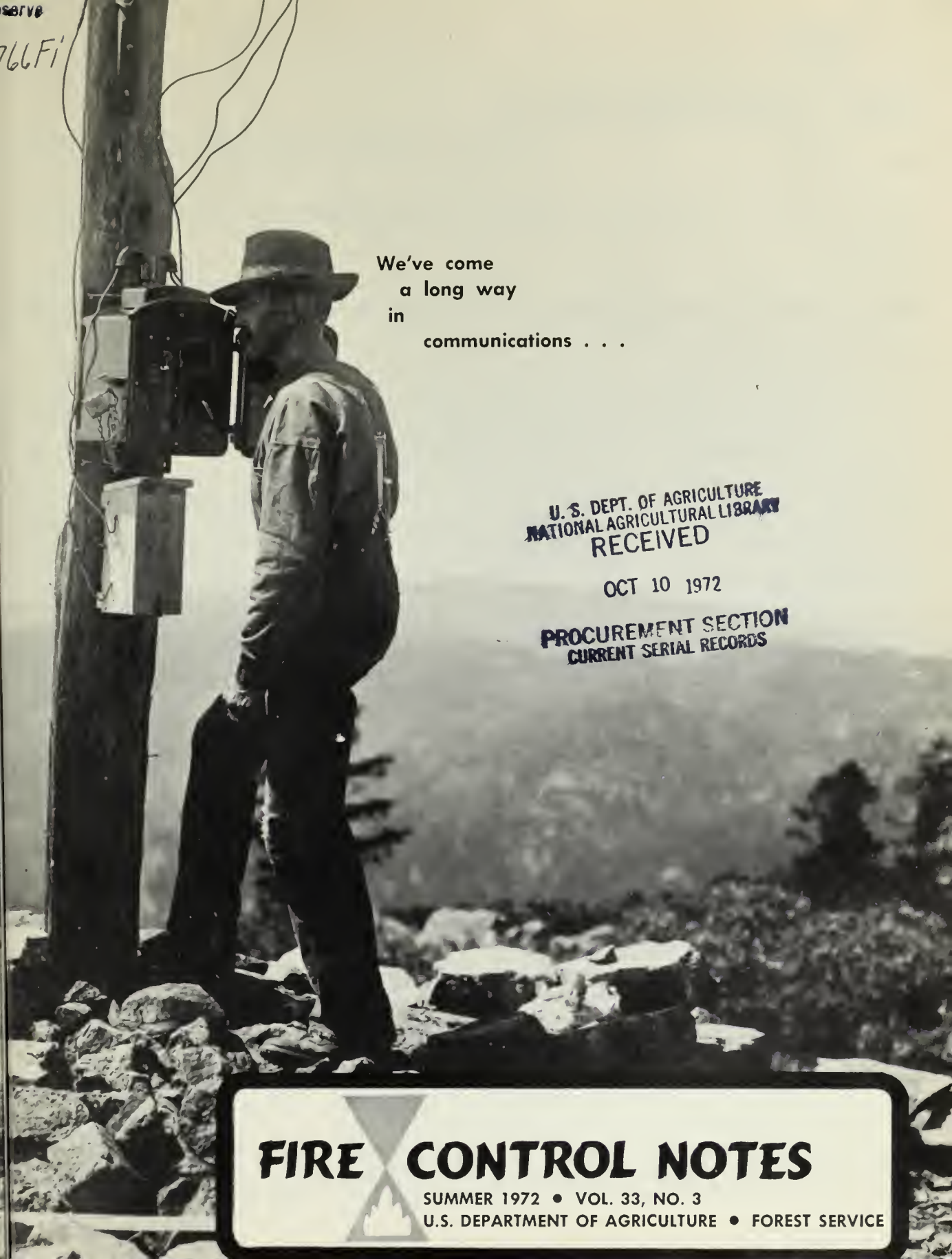


Routed letters
Yellow Cream
No. 23695
(Reflectorized)



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FIRE CONTROL NOTES

SUMMER 1972 • VOL. 33, NO. 3

U.S. DEPARTMENT OF AGRICULTURE • FOREST SERVICE

FIRE CONTROL NOTES

An international quarterly periodical devoted to forest fire control

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Norman C. Anderson and Dale Peacock

The cover picture was taken in 1931, 31 miles NE of Crescent City, Calif., on the Siskiyou NF and shows Guard Morgan reporting to the district ranger about the Bald Creek Fire.

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Earl L. Butz, *Secretary of Agriculture*

John R. McGuire, *Chief, Forest Service*

Henry W. DeBruin, *Director, Division of Fire Control*

Edwin J. Young, *Technical Coordinator*

Sigrid Benson, *Managing Editor*

The National Fire-Radio Cache Is a Module System at Work

Norman C. Anderson and
Dale Peacock

The National Fire-Radio Cache is an organized network of communications equipment and frequencies for use on large fires. Assigned frequencies reduce communication interference. The Cache system has been tested and used. It will be completed as funds become available.

Poor Communications Are A Hazard

How many times have you heard of a large fire situation where inadequate communications contributed to loss of life, property, resources, or the fire itself?

A giant step toward overcoming inadequate communications is to provide a complete communication system. This system must be transportable and self-contained, meeting all activity requirements. It must be easily and quickly placed in operation.

The National Fire-Radio Cache began with establishing frequencies (fig. 1). This plan provides for: six air frequencies, five fire command and tactical frequencies, two crew frequencies, and three pairs of repeater frequencies.

Norman C. Anderson is Forest Service Administrator, Boise Interagency Fire Center.

Dale Peacock is National Fire Radio Cache technician, BIFC

The National Fire-Radio Cache at Boise Interagency Fire Center contains elements for a large fire ground attack radio system. It consists of six Division Modules, two Fire Camp Units, and a Repeater Unit.

Each Division Module (fig. 2) contains 15 radios, complete with replacement batteries, in a fiberglass box (packed weight approx. 110 lb.):

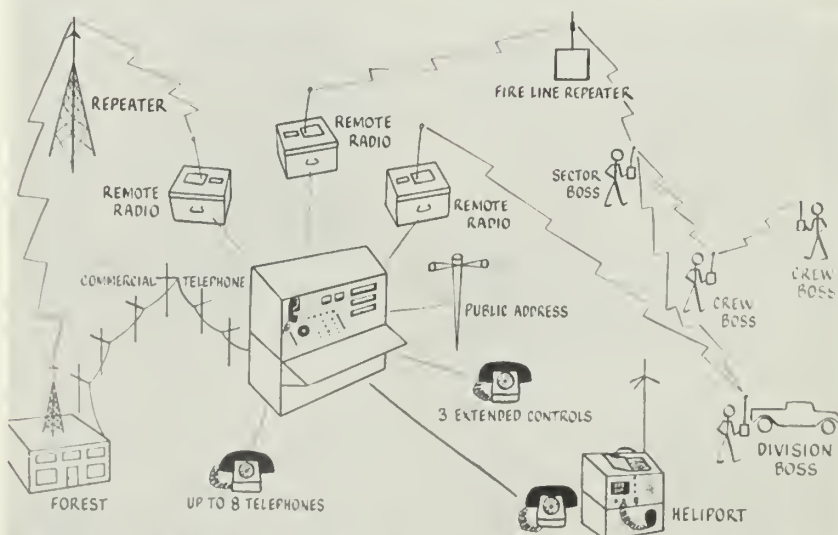
1. One Division (command) Radio
(5-frequency personal portable radio)
2. Three Sector (tactical) Radios
(5-frequency personal port-

able radios)

3. Nine Crew Radios
(2-frequency personal portable radios)
4. Two Special Assignment Radios
(2-frequency handie-talkie radios)

Each Fire Camp Unit consists of 11 fiberglass boxes, (packed weight about 110 pounds each). These boxes contain:

1. Remote, 2-way radio communications for 4 frequencies.
2. A camp telephone system.
3. A camp PA system.
4. One portable 360-frequency VHF radio (fig. 3).



NATIONAL RADIO CACHE SYSTEM

FREQUENCY ASSIGNMENT

LINE *168.050 Mhz

168.100 "

168.775 "

169.200 "

169.900 "

AIR 168.025 Mhz

*168.050 "

168.075 "

168.600 "

168.625 "

168.675 "

CREW *168.050 Mhz

168.200 "

REPEATER

1 { 168.700 Mhz
170.000 "

2 { 170.450 "
170.975 "

3 { YET TO BE
ASSIGNED

*NATIONWIDE

Figure 1. The frequency plan assigning use on large fires is the foundation for implementing the National Fire-Radio Cache System.

5. Four Division Radios, 5-frequency personal portable for overhead and special assignment.

- Fire boss
- Safety officer
- Line boss
- Air attack
- Heliport

6. Five Crew Radios, 2-frequency handie-talkie for replacement or special assignment.

7. Fire Camp console (fig. 4).

The **Repeater Unit** comes in two boxes, packed weight 40 lbs. each.

Romero Fire Benefits from the Cache

During the summer of 1971, the National Fire-Radio Cache, at the Boise Interagency Fire Center, was made ready for use. A call came from the Romero Fire and on October 9, within 1½ hours after arrival there, the radio system was in use. Romero fire communications requirements included:

- Fireline and fire camp coverage over rough, front-

country terrain and possibly over a main ridge.

- A tie-in from at least one spike camp with main fire camp.
- Provision for ground control and dispatch of helicopters at main heliport.
- Communications for one-way road traffic control.
- Communications for various agency and forest ground tankers in the tanker pool.
- Intra - crew communications.
- Communications for special critical burnout operations on one division.
- Additional frequencies for separating air operations for California State Division of Forestry.

These requirements were met by:

- A repeater installed on a ridge. All line personnel down through sector boss and fire camp were tied in to the repeater. The line overhead were given 5-frequency "Sector Boss Ra-

dios" with the repeater frequency. The fire camp had three 10-watt base radios and one with the repeater frequency. The fire camp also had service net, Forest net, PA System, and camp telephone network.

- A 5-frequency "sector boss radio" with service net tie-in to the spike camp.
- A 360-frequency VHF, battery-operated radio, which provided the base heliport communications and was assigned an emergency FAA frequency.
- "Division radios," assigned to "switch position 1" for traffic control personnel. Note: Repeater requirement made the Division radio unsuitable for line overhead use.
- Extra handie-talkie type crew radios on "switch position 1" assigned to various ground tankers. Tanker boss tie was with "Sector radio."

Figure 2. One Division Module, 18 5- and 2-frequency radios with replacement batteries, weighs 110 pounds in shipping container.



6. Crew radios used "switch position 2."
7. Sector boss monitoring crew radio on "switch position 2."
8. A 5-frequency "Division radio" for the critical burn-out division boss, linked to rest of fire with "Sector radio."
9. Additional VHF emergency FAA frequency obtained and put into use after first frequency became congested.

See chart; National Fire-Radio Cache System.

Cache Judged 90% Effective After The Romero Fire

An informal questionnaire was distributed to the last shift of line overhead on the Romero Fire. The results indicated the "Module System" was at least 90 percent effective. Some of the comments, remarks, and ideas from the evaluation were:

- The "Module System" is an improvement and is workable.
- The "Module System" is flexible and provides adequate fre-

quencies and equipment to meet large fire needs.

- A communications officer and National Radio Cache Technician is needed to accompany the National Cache until sufficient fire communications officers can be trained.
- Three of four frequencies were adequate to handle the total fire traffic with no overloads even during shift changes.
- The air operations of the National Fire-Radio Cache System needs to be implemented as soon as possible. FAA emergency VHF frequencies are a good backup until a National Radio-Air Operations System becomes a reality.

Fill Out A Fire Order For The Cache

Requests for the Cache are made by Fire Order to the Forest Service Coordinator, Boise Interagency Fire Center, 3905 Vista Ave., Boise, ID. 83705. An individual Division Module (15 radios) can be ordered. When three Division Modules are ordered, a Fire Camp Unit and National Radio Cache technician accompanies the Cache. The Repeater Units will be sent only by request.

The technician will assist and advise the fire communications officer in the implementation of the Cache System and arrange for return and maintenance of the Cache. The National Cache



Figure 3. Technician Bill Borrus, BIFC, at the portable 360-frequency VHF radio has own power supply and can be positioned any place air-ground communications are needed. Need requires approval for use of emergency FAA frequency.

at the Boise Interagency Fire Center has the capability of maintaining six Division Modules within 48 hours.

BIFC Provides Training

A module system brings with it training needs. To date, this has been done by the National Cache technician at fire schools and communication officer's workshops. This training will continue as BIFC gets requests. Actual fireline communication systems training is done when the National Cache technician assists on fires. Slide tapes and written material are now being prepared to inform fire managers about the use of the new National Radio Cache System.

First, Finances, Then The Future

Fireline—The present plan calls for 36 Division Modules with an accompanying Fire Camp Unit

for each three Division Modules. Immediate need is: financing to implement the rest of the plan: 30 more Division Modules.

Fireline Repeaters—The Cache presently has two fireline repeaters with associated frequencies. For full system implementation, ten more repeaters and one more pair of repeater frequencies in the fireline frequency

range are needed.

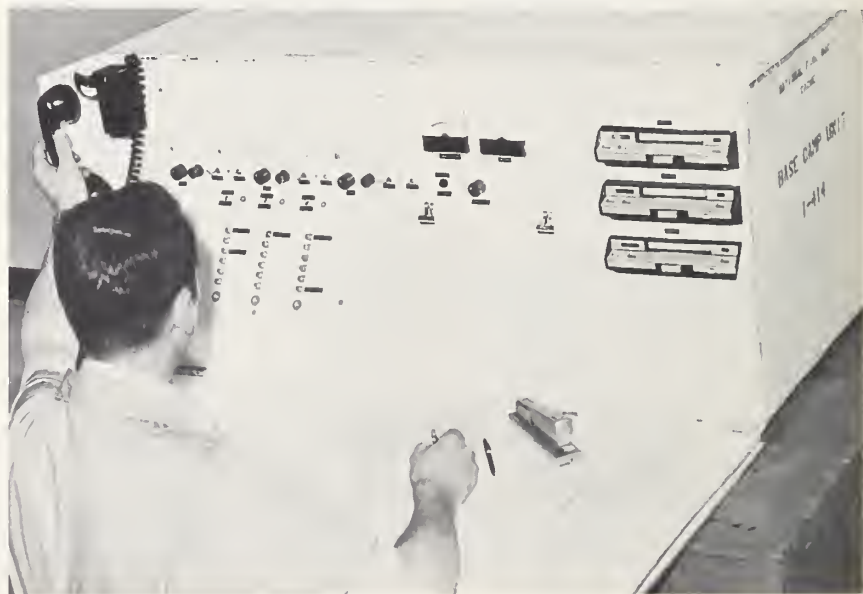
Service Nets—One service net is presently available with 11 more needed and two more pairs of repeater frequencies are required to meet service needs.

Air Net—No actual implementation of the Air Net is possible yet. The air net will make it possible to tie in six air frequencies with the ground and provide a way for the fireline frequencies to be available in a single multi-channel radio.

Suitable multi-channel radios are manufactured and the market is becoming competitive. Implementing the Air Net system awaits financing. With it Forest Service aircraft will be equipped with high band F.M. 4800 channel radios. Provision in the National Cache will be made to furnish contract and rental aircraft with multi-channel radios.

But the module system now available can help sort out communications on a large fire. Could the system work for you? 

Figure 4. Fire Camp console provides 1 location for radio operator to handle all radio telephone for public address communications. NOTE: Features remote capabilities for four of the fireline frequencies.



Fire Is a Terror...But Also a Tool

Richard E. Baldwin

Instead of promoting only the idea that all fires are *bad*, fire prevention efforts need to emphasize fire as a forest management tool and as a natural environmental happening.

Smokey Is A Good Teacher

The Cooperative Forest Fire Prevention (CFFP) program with Smokey Bear as the symbolic image of fire prevention is an impressive success story. The millions of dollars of advertising services contributed to the program have paid off in resources saved even though the saving can't be accurately measured.

Many dedicated fire protection people have been swept into the main stream of the mass media approach to fire prevention, and today fire prevention is almost synonymous with public relations, Smokey Bear, and the idea that all fire is bad. For example, if you are considering hiring a fire prevention specialist, what is one of the first prerequisites for the man? You probably will say, "He must be good in public relations."

Prevention Has Many Facets

But there are other aspects and approaches to fire preven-

tion that probably need increased emphasis, such as prevention engineering and fuel management.

Consider fuel management. Why isn't more effort put into it? Fuel management requires scientific understanding of fire behavior and fuels. Unlike the mass media approach, the results of fuel manipulation designed to prevent fires can be realistically tested, measured and evaluated to determine cost benefit answers. The results of the mass media approach, on the other hand, cannot be precisely determined. Furthermore, these results are in terms of the number of people contacted and not in terms of actual resource damage averted.

Are We Our Own Victims of Oversell?

Early day lumber companies harvested vast areas in a devastating and reckless manner with little concern for the soil, fire hazard, or perpetuation of a healthy forest cover. Because the silvicultural methods of clearcutting were carelessly applied, the public was aroused and educated to believe that clearcutting was all bad. Did forest managers oversell the public to the point that scientific management is seriously hampered today?

Can this same question be put

to the "all fire is bad" type of prevention program mentioned earlier? Will the public be able to accept forest fires as a fact of life, that fire's impact on forest ecosystems is as elementary as soil, air, and water?

Educational Reemphasis Needed

Fire prevention efforts must cease trying to manipulate public attitudes with single objectives as if it were selling a brand name soap powder. Educational programs should complement overall land management objectives. Since wildfire has been generally misrepresented as being bad, this concept needs to be tempered, and the natural role of fire in our forests emphasized. The public needs to learn that fire is a dynamic factor of the forest environment, not necessarily good or bad but natural.

A. B. Mount, silvicultural research officer from Australia, made the following observation after visiting fire research organizations in our country:

I was told that anti-pollution authorities are about to ban forest burning in Oregon; this in spite of general recognition by most foresters that fire is an integral part of the local forest environment. However,

Richard E. Baldwin is chief, Fire Programs Branch, Division of Fire Control, Missoula, Mont.

this recognition has apparently not been strong enough to allow a vigorous campaign of public education on the need for forest fires. Perhaps if the complete role of fire in the environment had been understood by the public, foresters would be more outspoken about their use of fire.

Mount also makes the following observation:

One remarkable difference between Australia and North America occurs after a fire disaster. In Australia there is public recognition of fuel accumulations and public pressure for the use of controlled fire to reduce these accumulations. In California there appears to be public condemnation of the firefighting organizations for not controlling the fire. It is apparently overlooked that the very efficiency of the fire brigades guarantees fuel accumulations that will one day produce a holocaust.

Fire's Natural Role Must Be Understood

Along with public reeducation, comprehensive burning prescriptions, realistic preattack planning, and fire prevention engineering through fuel and vegetative manipulation must constitute the backbone of the approach to fire management in the 1970's. When fire's natural role in the environment and its ecological significance are understood, land management programs will be able to complement natural processes instead of trying to overpower them with man's advanced technical skills and machines. △

Aircraft Altimeter Can Be Used To Set Up Hose Relay Lines

J. Leo Cote

In areas with rapid elevation changes you can lay an effective multiple relay pump line by using an aircraft altimeter.

On one of Connecticut's stubborn back-country fires during late June 1971 it became necessary to set up a multiple relay pump line a distance of 7,500 feet, with a substantial elevation rise. To place the pumps properly in relation to both the horizontal lay and vertical rise, with performance ratings of each pump known, Al Goldstone, foreman at People's State Forest Headquarters and I resorted to a "gimmick" that we have used before: A standard aircraft altimeter. It is a free operating unit requiring no wires or piping for use and is small enough (3 inches diameter and 4 inches long) to fit in your pocket.

Start at water source or first pump unit. Jot down altimeter reading. Graduations are 20 foot; in-between markings can be interpolated if you wish to be that accurate. As hose line is laid, the number of lengths can be counted for horizontal distance. Watch the altimeter, and difference between starting point and second location will give you vertical rise. You can then set your second pump in relation to the known ratings of the first

J. Leo Cote is assistant fire control officer, Department of Environmental Protection, Preservation and Conservation Division, Forestry Unit for the State of Connecticut.

pump. This procedure can be continued if a third pump is necessary.

Altimeters Not Expensive

The altimeter need not be an expensive instrument; we got ours from Federal excess property.

The altimeter does not have to be set at an exact elevation when you start, because for your purpose, only the relative values between stations are important.

The value in establishing a well planned hose line pays dividends in assuring continuous water up where it's needed. Our system can give a measure of confidence when the pressure is on. △

Aircraft altimeter used to determine height in feet-of-water "lift" from pump to fire (1 foot water = 0.43 p.s.i., 1 p.s.i. = 2.3 feet).





10 2001 This Smokey Bear Is Ready To Go ... and So Is His Station

James D. Moore and
Paul E. Pendowski

In preparing for the 1971 Wisconsin State Fair, the Lake Michigan District of the Wisconsin Department of Natural Resources created a unique addition to their fire prevention displays. It was a prefabricated, easily transportable, ranger station with which Smokey appeared.

The station, designed and built at the Wausaukee Ranger Station, has a base 5 x 8 feet, and is 6 feet high. An operator works inside and "Smokey" appears on the porch.

Ease of Upkeep and Transport Built In

An exterior, dark wood stain was brushed on the station, and the roof was made of unpainted

cedar shakes. The stain offers the convenience of on-site touch-up in case sections are marred in transportation or setup.

A white birch fence was put in front of the station. Besides being attractive, the fence holds spectators back. The entire station can be assembled or disassembled by two people in less than 1 hour.

The complete station consists of 11 prefabricated sections. The

James D. Moore is a forest ranger at the Wausaukee Ranger Station, and Paul E. Pendowski is a forest ranger at the Pound Ranger Station for the Wisconsin Department of Natural Resources.

entire station when disassembled can be carried in a pickup truck.

Only One Operator Is Needed

The station requires only one operator working behind the framed window, which is one-way glass on the front of the station. Sitting behind the window, the operator can be the voice of and operate Smokey unseen.

Because many appearances are during the summer months, it is important that the operator's quarters be well ventilated. Decorative louvered windows and a roof vent provide fresh air.

The Smokey that travels with the station is made from a tanned black bear hide mounted over a wooden frame. The headpiece has a movable jaw to simulate talking. A speaker is mounted at the neck inside the bear suit. With the use of an Army surplus Signal Corps amplifier, the "Smokey" can talk to the crowd.

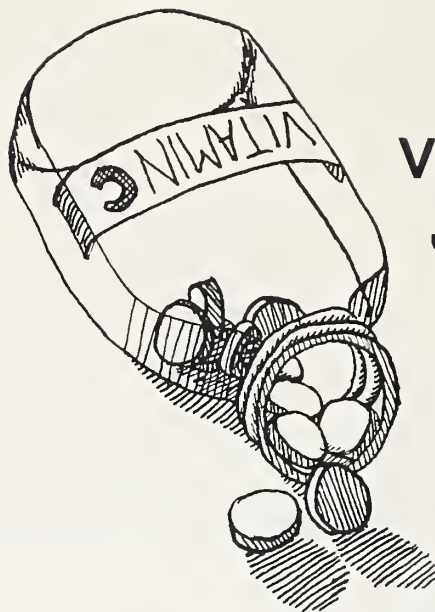
It Worked for Us . . .

How About You?

During 1971, the Smokey Bear Ranger Station appeared at the State Fair, a county fair, and the Peshtigo, Wis., Fire Centennial. At every appearance Smokey and his station were a definite attraction.

Using this station, we have been able to present an attractive and popular fire prevention display with a low manpower requirement. Because of the hidden operator, Smokey can "talk" to spectators and accomplish his prevention campaign most effectively — person to person.

If you want more information, write to Stanley W. Welsh, administrator, Department of Natural Resources, 4610 University Ave., P. O. Box 450, Madison, Wis. 53701. 



Vitamin C Is An 'Ounce of Prevention'

*Philip V. Cloward and
Bill E. Williams*

During the 1971 fire season vitamin C tablets helped keep the Sawtooth Interregional fire crew in good health.

Each year many men suffer respiratory illnesses on interregional fire suppression crews. These crews spend a lot of time on the fireline each season. Smoke, dust, long hours, and temperature extremes are conditions common to crews on most of the fires they fight. Under these conditions, colds, flu, bronchitis, and other infectious diseases flourish, sometimes spreading through an entire crew in a few days.

Illness Reduces Crews' Effectiveness

With the Sawtooth Interre-

*Philip V. Cloward is TM-FC staff officer and
Bill E. Williams is supervisory fire control officer, both on the Sawtooth National Forest.*

gional Fire Crew, based at Twin Falls, Idaho, these illnesses were a major problem each year from 1967 through 1970. During that time there was one case of pneumonia as well as many serious infections requiring a doctor's care. During the 1969 fire season, for example, 27 of the 30 men on the crew received treatments for respiratory ailments.

This much sickness seriously reduced the crew's effectiveness, especially late in the fire season when most of the colds and flu occurred. Several times crewmen had to be flown home from a fire due to illness. This resulted in increased transportation costs.

Vitamin C Used

During the 1970 season, three men on the Sawtooth crew took vitamin C capsules daily throughout the season on a trial

11-12

basis. They had fewer and milder colds than the rest of the crew. None of the three missed a fire due to sickness. The rest of the crew didn't fare as well. Many had to get treatment, and some were sent home sick.

Based on the results of this trial, enough vitamin C was purchased to give each man one 250 mg. tablet every day throughout the 1971 season. The 2,500 capsules needed cost about \$30 and were made available to the crews. All members but one elected to take the tablets.

The results were surprising. Colds and flu were not a serious problem during the 1971 season. No one had a serious respiratory ailment, and colds were fewer and less severe. In 1970, the crew used 344 hours of sick leave, but in 1971, while taking vitamin C, the crew used only 124 hours of sick leave. Furthermore, the crew went on more fires in 1971 than in 1970.

For the first time in 5 years, the crew members were all still healthy at the end of the season. From now on, vitamin C will be dispensed to the Sawtooth crew as a very worthwhile "ounce of prevention."

Vitamin C Is A Glue

Dr. Lee Buchanan, Medical Officer for the U.S. Department of Agriculture, explains the need of vitamin C in our bodies: The vitamin acts as a glue between the surface cells, including throat and lungs, thus increasing our resistance to disease.

In times of stress, such as fighting a fire, our need for vitamin C increases. Dr. Buchanan says 250 mg. is a safe dosage and may well be effective, especially when fresh fruits are not available. 

Float Plane Mounted,

Scanner Reads Reflections As Well As Fires //

Frank J. Squillace and
William O. Beel

Because of the many lakes in the roadless wilderness of the Boundary Waters Canoe Area, float planes patrol the forest for fires. An infrared scanner has been placed on a float plane to detect fires; however, reflections from the lakes have caused most of the false readings.

Unit Has To Be Waterproofed

The infrared scanner¹ is mounted on the bottom of the

*Frank J. Squillace is forest dispatcher, and
William O. Beel is chief pilot,
both of Superior National
Forest.*

fuselage of a float plane for testing and evaluation (fig.). Wing tip mounting is not possible because the floats would interfere with the scanning. Because of the quantity and velocity of water striking the device on take-off and landing, the unit was waterproofed with a combination of silicone rubber, plastic tape, and cement. The power cable was put through an inspection hole in the fuselage and up to the instrument panel. New

¹ See "No Smoke Needed," by Robert F. Kruckeberg, FCN, Vol. 32 No. 2, Spring 1971.

Scanner (arrow) is mounted under the airplane, to the rear.



weight and balance figures were computed and they fell well inside the aircraft safety envelope. Flight tests were made both at light and gross weights without any noticeable change in flight characteristics.

Initial Test Successful

In the fall of 1970, tests of the scanner were conducted. A charcoal fire, 1 foot across and 3 to 4 inches deep, in a garbage can cover, was placed in the woods. Positive location of the fire was not known by the aircraft's occupants. The plane was flown over the general area at an altitude of 1,000 feet. The detector immediately picked up the fire.

Tests were also made at 2,000 feet. Some skipping effect was noted, but the detector pinpointed the fire within 200 feet of its location at ground level.

False Readings Take Up Time

More tests were conducted in the spring of 1971, when patrols were flown at an altitude of 2,000 feet. Three pilots each flew 2-hour patrols with similar results; the scanner flashed almost constantly from water reflections, making its use on a routine patrol counterproductive.

The pilots used much of their time checking false alarms and resetting the instrument and did not have time for adequate visual scanning. Numerous false alarms disrupted the flight pa-

trol detection pattern causing considerable delay in the schedule.

The scanner was more reliable during the mopup operations on the 14,629-acre Little Sioux Fire during late May and early June of 1971. On 3 consecutive days pilots flew a total of 17 hours and found 40 hot spots, some of which would have been missed due to lack of visible smoke. Best success in locating the hot spots was during the early part of the mopup period.

In August 1971, the scanner was used in an attempt to locate lightning fires in an area of mixed forest and lakes. Use of the scanner was discontinued on this project because of continuous false alarms caused by water reflections.

Some false alarms were recorded from other sources. Operation of the aircraft radio (XMIT) actuated the unit. The rotating beacon mounted on the bottom of the aircraft reflects on the floats. The sun actuated the unit in a turn. False readings were recorded from reflections off natural rock outcrop areas, concentrations of bottles and cans, and from the cabs and windshields of vehicles.

If the sensitivity of the scanner can be reduced to overcome false alarms and still locate fire on patrol flights, the scanner can be an effective tool for detecting fire in the Boundary Water Canoe Area. 

Prescribed Burning

Particles and Air Quality Studied

Ward, D. E., and R. C. Lamb.

1971. Prescribed Burning and Air Quality — Current Research in the South. Tenth Annu. Tall Timbers Fire Ecol. Conf. Proc. 1970: 129-140.

Describes pilot studies to

determine particular production of burning forest fuels and to correlate particulate concentration with smoke plumes. Techniques involved use of high-volume samplers and optical particle counters.

National Fire Danger Rating System Is Explained In New Book

Three innovations in fire-danger rating are introduced in the NFDR System. First, it is solidly based on the physics of fire behavior; it is not empirical or statistical. Second, it makes use of the fuel model, an open-ended means of treating the myriad of naturally occurring fuel situations. Third, the system is designed so that improvements can be incorporated with a minimum of impact on the users.

1972 The National Fire-Danger Rating System;

by John E. Deeming, James W. Lancaster, Micheal A. Fosberg, R. William Furman, and Mark J. Schroeder; USDA Forest Service Research Paper RM-84, 165 p. Available from Rocky Mountain Forest and Range Experiment Station, 240 West Prospect Street, Fort Collins, Colo. 80521.

The National Fire-Danger Rating (NFDR) System produces three indexes — *Occurrence, Burning, and Fire Load* — that measure relative fire potentials. These are derived from the fire behavior components — *Spread, Energy Release, and Ignition* — plus a consideration of *Risk*.

Instructions and tables necessary to manually compute the indexes and components for all nine fuel models are presented.



Smokeyumper Cargo Rolls

Dale E. Major

By using a roller track arrangement for smokejumper cargo (fig. 1), up to three fire packs can be dropped with each pass of the airplane. This not only saves time; it also reduces the hazard of low-level cargo passes over rough terrain.

In previous years the method for dropping cargo has been to push one two-man pack across the floor of the airplane and out the door for each pass of the airplane. The one-pack-per-pass has been necessary because each fire pack weighs 90 pounds. But now, the roller track bears the burden.

When the roller track is not in use, it can be stowed out of the way of other operations by means of a harness bolted to the bulkhead (fig. 2). The track can be removed from the aircraft by

undoing four cap screws.

Present-day installations of roller track in DC-3 airplanes do not allow for smokejumping when the track is in use. 

Using a roller track arrangement, up to three fire packs or up to five smaller bundles can be dropped during one pass



Dale E. Major is FS deputy regional air officer at the Boise Interagency Fire Center.

Ignition of Prescribed Burns More Reliable

Electrical Igniter Tests Circuits

William A. Main and
Peter J. Roussopoulos

One of the recent advances in prescribed burning technology has been the development of remote ignition techniques. Hand-thrown grenade-type ignition devices (Dell and Ward 1967; Fenner 1962), mechanically launched incendiary projectiles (Dell and Ward 1967a), and electrically ignited fuel boosters (Reifsnyder 1952, Fenner 1962, Schimke et al. 1969) are foremost among the devices tested. Studies by Murphy et al. (1968) indicate that electrical ignition systems can be successfully used to manage smoke dispersal for minimum air pollution impact. The following article is about building safety and reliability into electrical systems.

The electrical squib igniter (ELSI) has been devised so that circuits can be tested and the ignition of prescribed fires can be more reliable.

Forest Service fire researchers at the North Central Forest Experiment Station have been using electrical ignition for several years in both experimental and operational burning. From the beginning it has been apparent that electrical ignition is not totally reliable. This makes pos-



Figure 1.—Top, front view and, bottom, rear view of the electrical squib igniter.

sible a potentially disastrous situation should a circuit fail during the actual firing process.

Ignition Circuit Malfunction Is Hazard

Briefly, every electronic ignition system for prescribed burning consists of: (1) a power source, usually a blasting machine, portable generator, or battery; (2) a wire or a similar conductor to complete the circuit between the power source and

the fuse lighters; (3) one or more squibs (electrically fired fuses); (4) a spitter-fuse or igniter cord wrapped around the squib; and (5) a fuel booster such as gelled petroleum.

The squibs are arranged in one circuit or several series of circuits, each circuit igniting a fuse when fired by an electrical impulse. Each fuse then lights one or more strategically placed fuel boosters that, in turn, provide an ignition source for the combustion of natural fuels.

Ignition circuit malfunction usually results from one of two causes:

1. The circuit may have been damaged, possibly by people, wildlife, inclement weather, or rolling material, preventing the flow of electrical current.
2. The power source may be run down or simply inadequate to fire the circuit.

Some Testing Dangerous

How might circuit viability be verified before the firing attempt? One possibility involves walking around and measuring the electrical resistance of each circuit with a blasting ohmmeter to determine requirements and ignition circuit continuity. You must be careful, however, that the ohmmeter power output does not exceed the firing power threshold of a single squib. Moreover, the practice of connecting each individual circuit to an ohmmeter first and then to the power source before firing is somewhat cumbersome in the

William A. Main is a computer programmer and Peter J. Roussopoulos is a research forester, both at the North Central Forest Experiment Station, USDA Forest Service. The Station is maintained in cooperation with the University of Minnesota.

field—a serious drawback when precise timing is required.

ELSI Tests Circuits

To increase safety and field convenience, an electrical squib igniter (ELSI) was designed and constructed to test and fire multiple circuit ignition patterns from a single point without reconnecting circuit leads during the firing process (fig. 1). It was used successfully on several prescribed fires and appears to be an improvement over conventional ignition power sources.

ELSI is portable, measures 8 x 5½ inches, and weighs about 3 pounds. As many as 12 ignition circuits can be simultaneously connected to the back receptacle panel, and each can be tested, fired, or both, as chosen by the operator turning the dial-type circuit selector switch mounted on the front of the assembly casing.

Circuit Design Incorporates Safety

Power for the ELSI is provided by a 12-volt DC internal battery with provision for additional external power. When toggle switch S1 is in the TEST position, the device is essentially a low power ohmmeter—incorporating a Wheatstone bridge (an electrical resistance measuring device) to easily measure squib resistances (fig. 2).

Circuit resistances between one and 16 squib equivalents can be fired by the 12-volt internal power source alone. This “go-zone” has been delineated on the meter face by the center colored arc; the “no-go-zones” are designated by a contrasting color (fig. 1).

Unit Just About Fail-Safe

Because accidental firing cannot be tolerated during circuit test procedures, two safety devices have been built into ELSI, making it essentially fail-safe.

First, two separate switches must be thrown to fire the circuit. S1 must be thrown to the ARM position to remove R4 from bridge circuit and make firing possible, and then S2 (which is spring-loaded on SAFE) must be thrown to the FIRE position to complete the firing circuit.

Only when both switches are thrown is maximum current allowed to flow through the squib circuit. The second safety device is a warning horn that informs the operator when the firing circuit is armed by S1. The combination of these two safety devices practically eliminates the possibility of accidental firing.

You Can Build One

ELSI can be constructed easily and inexpensively. Materials and components of the prototype were purchased for about \$43 plus battery.

Since internal meter resistance varies between different kinds of meters, each meter has to be calibrated.

Write William Main; 215 Na-

tional Resources Bldg., E. Lansing, Mich. 48823; for information.

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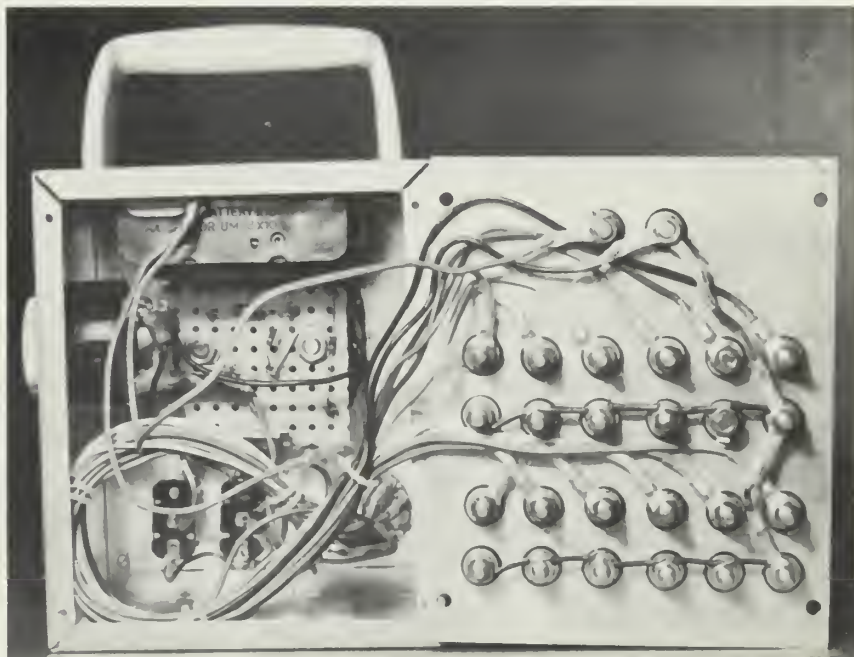
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Figure 2. Internal anatomy: note “Perf” board in rear.



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First Intercompact Agreement Signed

An agreement expanding mutual aid assistance in forest fire fighting and training between the Middle Atlantic Interstate Forest Fire Protection Compact and the Southeastern States Forest Fire Compact Commission was signed in Harrisburg, Pa. on February 2, 1972.

Attending the signing ceremony were (l. to r.): Philip L. Archibald, USDA, FS; State Foresters — Samuel S. Cobb, Pennsylvania; Samuel V. Mace, Delaware; George R. Moorhead, New Jersey; Lester McClung, West Virginia; A. R. Bond, Maryland; George W. Dean, Virginia; and Ronald C. Schureman, Kentucky.

Samuel V. Mace, chairman of the Middle Atlantic conference, and Ronald C. Schureman, chairman of the Southeastern States conference, both signed the agreement for their conferences. 



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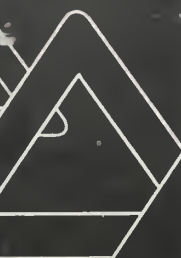


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FIRE CONTROL NOTES

An international quarterly periodical devoted to forest fire control

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Earl L. Butz, *Secretary of Agriculture*

John R. McGuire, *Chief, Forest Service*

Henry W. DeBruin, *Director, Division of Fire Control*

Edwin J. Young, *Technical Coordinator*

Sigrid Benson, *Managing Editor*

National Fire Training is 15 Years Old and Still Growing*

G. E. Cargill

It is almost 15 years since the first National Fire Behavior Course at Missoula, Mont. Let's put these years of fire training in perspective — where we've come from, where we are, and where we might be headed in fire training during the next few years.

The Need Was Seen in 1956

Nineteen hundred fifty-six was a bad fire year. It was the year of the Inaja Fire when 11 firefighters were fatally burned. There was a great deal of inter-regional movement of fire suppression overhead and crews. As a result of the Inaja fire tragedy, a task force was assigned to find out what could be done to reduce chances of men being trapped and burned while fighting forest fires. Finding a need for increased knowledge of fire behavior, the task force accomplished the following: During 1957 and 1958 a pamphlet, "Safe Practices Under Blowup Conditions" was issued; the "10 Standard Firefighting Orders" were written; four new fire control training films were started; a National Fire Control Training Handbook was published;

G. E. Cargill is in Fire Training in the W. O. Division of Fire Control.

and in 1958 the first National Fire Behavior Course was held in Missoula, Mont. This course was followed by other courses in fire behavior and large-fire management (fire generals) held at various places throughout the country.

During the '60's instruction was designed to help people to learn more efficiently. The challenge to fire control was (and is) to analyze what the training needs are and to adapt new training techniques to meet the needs. It became clear to the Forest Service that a full-time man was needed to help obtain the quality of fire control training desired in the quantity required. As a result, in 1967, the National Fire Training Center was established at Marana, Ariz., with Ed Heilman as Director.

Three Levels of Courses Available

How does National training fit the overall Forest Service fire training program? There is some variation, but for the most part advanced courses are held at the national level, intermediate courses are given at the regional level, and basic courses are given at forest and ranger district levels. As a region or zone gets enough trained instructors and lesson material, an advanced course can be given in



the region, allowing the national courses to tackle new problems.

Training programs at all levels should be based on an analysis of training need. Looking at performance in various activities and analyzing the deficiencies found, we in fire training ask: "Is this a deficiency which training can correct?" We know training cannot solve all of our problems. Since time, money, and available people are limited, we have to train in areas where we have the greatest chance of improving performance.

Training Packages Developed

We are developing multimedia training packages because we have found that motion pictures by themselves are not very efficient training aids. The most recent training package is a Helitack Training Guide incorporating lesson plans, slides, vignettes, and other visual aids. Slide-tape programs have been useful, and we are developing more of them since motion pictures cost so much.

A sector boss training package now being developed features a film as the primary aid and includes lesson plans based

* This article is adapted from a speech given to the National Research Council Associate Committee on Forest Fire Protection, Petawawa Forest Experiment Station, Chalk River, Ontario, Canada, Oct. 26, 1971.



... the fire trainer has to be out in front, anticipating change and preparing people for it

on it. Unfortunately it takes a lot of time to create, print, and distribute the material.

Publications such as *Equip Tips* and *Fire Control Notes* are important ways to distribute information regarding new products from our equipment development centers. We also need to spread the word about inter-regional fire training aids.

Magnetic video tape systems (VTR) were used to record instructor presentations at a recent national course. They helped improve the instructor's performance. We have made limited use of VTR for recording classroom lectures to be played back at a later date, but we plan increased use of VTR in our training programs. Lack of industry standards in hardware is a problem for us.

Training Doesn't Always Make It to the Field

We're still finding breakdowns in transfer of knowledge from the classroom or from programmed instruction to the field. Simulation is one of the effective means we know to improve this transfer, but only relatively few top overhead have had the opportunity to use the large fire training simulator. The 1972 Fire Generals Course will not

include a simulator problem because "like real" Class I problems do not require visual simulation. We have occasionally used equipment at quite an expense in relation to training value acquired.

The compact fire training simulator should bring lifelike experience to people in mid-overhead positions and to initial attack firemen. Our problem presently is not lack of technology in simulation or student response; it is developing enough good programs which involve the student and require him to respond to the training. We need to share the few good programs we have.

Other Problems Remain

What are some of the other problems facing us in fire training? For one, it is difficult to obtain good instructors. It requires about 10-20 hours of preparation for every 1 hour of instruction, and with increased demands on time, we're finding it difficult to find technically competent people who are good instructors and are available to teach.

Another problem is reaching enough people, which is complicated by attrition, transfers to other duties, etc. The problem

extends to the ranger district level. In some locations,¹ we are experiencing an 80-85 percent turnover in seasonal work force each year. This means each year we start with individuals who have no carryover experience or knowledge on which to build. We have to refocus our attention on training packages the district and forest can use to teach basic firefighting skills. This year we are doubling the number of trainees at our fire generals course and staggering the classes so each instructor presents his material twice.

Evaluation of training remains a problem. So far, we have depended mainly on subjective reports from trainees after they have completed courses. What is needed are better performance evaluation reports on how men do the job for which they are trained. In other words a "feedback loop" to give direct results of our training. Right now, this is a missing link in the overall training system.

A Future Problem: We Must Keep Up with Technology

In the 25,000 years of man's existence in North America

¹ "Manning, A Region-3 Report," Div. Fire Contr., Albuquerque, N.Mex.

there have been about 400 lifetimes of 60-70 years each. The first 250 were spent in caves—fire was friend and foe then, too.

Only during the last 70 lifetimes has it been possible for man to communicate in writing what he knew about fire—or anything else. Only during the past six lifetimes did masses of men ever see a printed word.

In the area of fire research, except for a few historic writings, almost all of the existing literature has been published since 1912. Furthermore, about one-half of the entire bibliography has been published within the last 30 years—the span of one career. Of perhaps more significance to the fire trainer is the fact that the number of fire research titles published during the 1960 decade is more than twice that of the 1950's.²

Technology Is Advancing Like Wildfire

A young man 18 years old going into fire control work in the year 1919, would have witnessed within his own lifetime the introduction of every one of the technological developments in fire management today, from aerial detection (1919) to the infrared "Hot Spotter" (1971).

The present rate of spread in fire control knowledge will probably continue, even accelerate. And when computer technology comes of age in fire control management, it will generate an unprecedented knowledge acquisition capability and an equally unprecedented knowledge distribution opportunity.

² 1630 Written Information: Forest Fire and Atmospheric Sciences Research Publications, 1950-1959: 368 publications; 1960-1969: 770 publications.

In order to keep ahead of the information, we are going to have to identify and anticipate those areas where training can improve future performance.

Cooperation Importance Stressed

The need for cooperation will continue and become even more important — between Federal, State, and local agencies; between management, research, and scholastic systems; between fire control professionals, land managers, and behavioral scientists; and between nations.

What will be needed in fire control training during the next few years? The result of the Oct. 26, 1971, meeting of fire control training officers is the start of a future forecast group to include technical people, behavioral scientists, economists, and people of diverse backgrounds.

The Speed of a Growing Tree Isn't Fast Enough

Perhaps because natural resource management is a long range proposition, we sometimes seem to utilize research efforts and technological developments at about the speed of a growing tree. This is fine insofar as it precludes overreaction to public fads and wild gyrations in land management policy; however, the fire trainer has to be out in front, anticipating change and preparing people for it.

Some mammals now extinct were in trouble when they got their feet stuck in tar pits. Among the tar pits of training are complacency, resistance to change, fear of new ideas, and bureaucratic inertia. Our challenge is to keep the fire manager and ourselves out of those tar pits. 

Mounted in Place Of Dozer Blade,

Crusher-Cutter Efficiently Disposes of Slash

William D. Shenk and Richard N. Harlan

Using the Tomahawk Crusher-Cutter¹ has proven to be a cheap, clean method of disposing of slash from logging and thinnings. The Tomahawk is effective in fuel modification in eastern Oregon, particularly with 1-year-old brittle slash. The Tomahawk is effective because of the front mount and even more effective with the blade removed because the operator can see the job ahead of him and maneuver easily around obstacles.

Trailer-type slash cutters are not as maneuverable when working in thinned stands of reproduction and poles.

Road Crusher Works Well on Slash

Originally developed for use in breaking up and compacting road surfacing material, the Tomahawk shows promise as a tool for fuel treatment.² Treatment is most effective when slash is brittle.

The Tomahawk can effectively crush material 4 inches in diameter and less. Also, if thin-

¹ Manufactured by the Young Corporation, 2917 East Marginal Way South, Seattle, Wash.

William D. Shenk is fire control officer, Deshutes National Forest. Richard N. Harlan is supervisory civil engineering technician, Fremont National Forest.



Before crusher-cutter treatment. Note two trees to man's left.

ning operations must meet specifications of 16 feet and wider spacing, conditions are ideal for an effective Tomahawk operation. One pass over an area is good; two are better, particularly when creating a grid pattern. The Tomahawk reduces hazard ratings very effectively in small limbed logging slash, such as that resulting from cutting lodgepole pine and from commercial and precommercial thinning.³

Costs run from \$20 to \$35 an acre, depending on many conditions such as slope, slash density, or equipment availability. While its use is still relatively new in slash treatment, the Tomahawk has been used in the Deschutes and Fremont National Forests for the past 3 years.

Use Hydraulic Dozer

A dozer with a hydraulic system, rather than a fixed blade, is better to use with the Tomahawk because it provides enough

²See "Reducing Fire Hazard in Ponderosa Pine Thinning Slash by Mechanical Means" by John Dell and Frank Ward, USDA Forest Serv., Pac. Southwest Forest and Range Exp. Stn., Res. Pap. PSW-57-1969.

³See chapter 5150—Fuel Management, Oct. '71, Amend. 35, Forest Serv. Man.

pressure to crush the slash. The power of a hydraulic system becomes more important when the dozer blade is removed and the Tomahawk is mounted directly on the yoke with the adaptor.

Disadvantages to bulldozer use with the blade on soon became apparent.

1. The Tomahawk was mounted with clamps to a dozer blade. Bolts used to tighten the clamps tended to shear, creating numerous maintenance shut-downs.

2. The tractor operator could

After crusher-cutter treatment. Man is now standing between the two trees noted in before picture.

not observe the Tomahawk in operation because the dozer blade obstructed his view of the machine and the ground immediately in front of the Tomahawk.

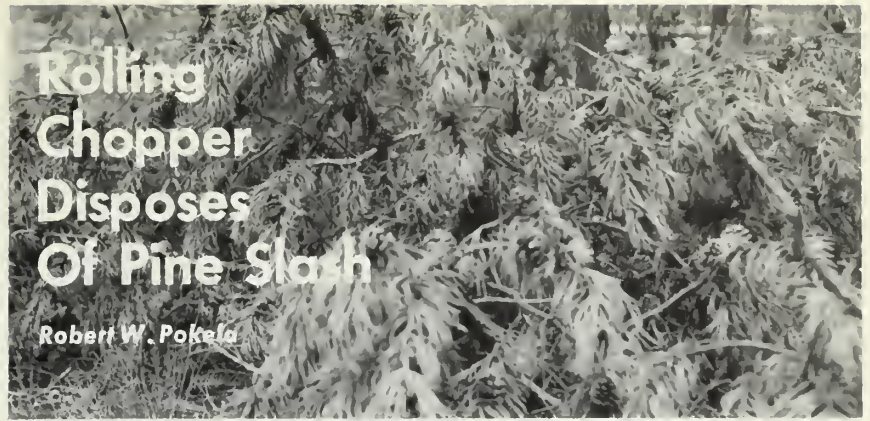
3. The Tomahawk was designed to revolve as it passes over the material being crushed: when the slash bunched up in front of the cutter and blade and when a chunk became lodged between the Tomahawk

Adaptor-mounted Tomahawk provides compactness and visibility.



Rolling Chopper Disposes Of Pine Slash

Robert W. Pokala



and the dozer blade, the Tomahawk did not operate well.

Adaptor All Important

To correct these deficiencies the dozer blade was removed and the Tomahawk mounted directly on the yoke or U-frame. To do this a local welding shop constructed an adaptor for \$230. One-inch steel was cut for the adaptor and was welded to fit the specifications of the yoke.

Operator Can See

A major advantage of mounting the crusher on the yoke is that the operator can observe the Tomahawk as it crushes.

Much crushing of thinning slash is done among spaced crop trees which must be protected from damage. The crusher on the yoke, blade removed, lessens the overall width of a crawler tractor. Also, if a leave tree is struck by the tractor, the yoke will damage it less than the corner of the blade, which ordinarily protrudes beyond the width of the yoke.

The use of the yoke-mounted crusher is encouraging. The whole crushing operation is faster, more efficient, and given greater maneuverability. And, not the least of considerations, with increased production comes the benefit of reduced per-acre treatment costs. 

*Forester,
Munising Ranger District,
Hiawatha National Forest*

Slash accumulations create a fire hazard, a barrier to reforestation, and an unpleasant appearance. The rolling chopper has proven effective in crushing heavy jack pine slash. Fire hazard is reduced; the site is prepared for reforestation; and the attractiveness, wildlife habitat, and general soil condition are maintained.

The slash described in this

article was on a 523-acre jack pine timber sale area on the Hiawatha National Forest, Michigan. When chopped, the slash varied in age from 6 months to 3 years. Chopping broke up the slash, placed it close to the ground, and partially mixed it with the soil, where fuel moisture is higher and more rapid deterioration takes place. Larger fuels, over 4" in diameter, were broken and flattened to the ground. Mineral soil was exposed over 40-60 percent of the area, break-

In many cases, the rolling chopper needs to make only one pass through slash.





Mechanical slash treatment permits protection of clumps or individual trees. A variety of species maintain esthetics and provide shelter and nesting sites for some wildlife.

ing up the continuity of slash. Rate of spread and resistance to control of fire was reduced from an estimated M-H to an L-M rating. Only one pass was required in light to medium slash. In heavy slash accumulations two passes were required to break up the slash.

The topography on the Hiawatha National Forest is flat to gently rolling. Soil is a Rubicon, a well-drained sandy soil with a thin (1"-2") humus layer. In this soil the chopper creates slits and mixes in the slash, improving soil structure and fertility and reducing erosion.

Trees Grow Again

The chopper exposes a suitable mineral soil seed bed necessary for seeds to begin and continue growth. The area cut and chopped requires supplemental seeding or planting to obtain a fully stocked stand. First year survey shows 38% stocking, and aspen sprout well where aspen trees were chopped. The serotinous cones of jack pine release thin seed at the higher temperatures found close to ground level. So the end result will be a jack pine stand with scattered pockets of aspen.

Opportunities to improve the esthetic qualities occur often. Small patches of aspen, young red pine, jack pine, or shrubs growing in the area can be left. Patches of black cherry, service berry, and white birch may also be present. All these patches may vary in size and location and will break up large openings often created in timber harvest operations. Islands of shrubs and non-coniferous trees reduce the artificial effect of solid rows of planted trees.

Wildlife Use Openings

The openings created by timber cutting are used by several species of wildlife. Whitetail deer feed on new sprout growth. Sharptail grouse, an important game bird, nest in large open areas. Nesting seasons must be considered to protect game and song bird populations if chopping is to benefit the birds.

Choppers Work in 'V' ¹

The rolling choppers are pulled in a dual arrangement by an International TD-25. Best results were obtained when the choppers were pulled in a "V" formation with the center back.

Each chopper drum is 7 feet

wide and 43 inches in diameter and is filled with fuel oil to avoid freezing. Full weight is 11,000 pounds. The chopper can be used effectively on slopes up to 20 percent. Areas should be reasonably free of boulders, rock outcrops, and swamps. Chopping can be done during most of the season when the ground is free of snow.

Production rate for single chopping averaged 2.1 acres per hour at a cost of \$11.49 per acre. A second chopping was needed in areas of heavy slash at an additional cost of \$4.71 per acre.

Rolling Chopper Provides Benefits

The use of the rolling chopper gives the Forest Land Manager an opportunity to reduce fire hazards while preparing a suitable site for reforestation. Changes in soil structure and fertility are not significant. Groups or patches of desired trees and/or shrubs can be left to provide important wildlife benefits and enhance the beauty of the forest.

¹ See "Disposal of Logging Slash with a 'Rolling Chopper'," S. H. Van and Dale E. Gallagher, FCN, 29:2(7), April 1968.

... water dropped from
helibuckets can provide a short-
term fire control line ...

Alaska's Extra Ace: Water Dropping

Nonan V. Noste and
Roy M. Percival

The U.S. Department of Interior, Bureau of Land Management, initiated water dropping by helicopter in 1968; and information on effectiveness was obtained through a cooperative effort with U.S. Department of Agriculture, Forest Service, during the 1969 fire season. On eight operational drops studied, the water line held satisfactorily on fine fuels. The study suggests that water dropped from helibuckets can provide a short-term fire control line under certain weather and fuel conditions.

The Fire Research Project at College, Alaska, has been studying methods of attacking wild-fire, including dropping water from helicopters and helitanks. In 1966, a helitank was purchased, and, in 1967, an exploratory study developed techniques for measuring ground distribu-

tion patterns, using a 55-gallon Monsoon bucket slung from a light helicopter. The Bureau of Land Management initiated water dropping by helicopter on an operational basis in 1968. Through a cooperative effort with the Forest Service, preliminary information on the effectiveness of water dropping was obtained during the 1969 fire season. The results follow.

Water Line Can Stop a Fire

Water line laid by a helicopter with a 450-gallon helibucket can stop a fire's advance. This was determined by a two-man team obtaining data on eight water drops. In each case, water was dropped from 450-gallon fiberglass helibuckets, cable slung from a helicopter. The ground team located and flagged the centerline of the drop pattern after the operational drop.

The minimum distance from the advance point on the fire front was measured at the time intervals of $\frac{1}{4}$, $\frac{1}{2}$, 1, and 2 hours. Six of the fires did not advance during the 2-hour period of observation. One fire did advance from 20 feet to within 18 feet of the centerline, and the other fire burned over after holding for 30 minutes. The

burned-over line held in the light surface fuels at the edge of a grass-sedge meadow but was overrun by a relatively intense front traveling through the adjoining willow brush.

The effectiveness of water dropping can be judged after considering the burning conditions. The water line held when rate of spread was 2 feet per minute (approximately 2 chains per hour) or less. Winds of 12 miles per hour, contributing to a spread index of 60, did not cause the fire to work its way through the water-treated strip, although ultimately the line did not hold. A problem with use of water for permanent line construction is escape of the fire when mopup is not thorough. The observations were made during routine drops on problem fires during an extreme season.

Water contained the fire satisfactorily in fine fuels during the eight drops (see table). Also when erosion potential exists, a water line would eliminate disturbance of protective surface vegetation. Maintaining the insulating effects of the surface vegetation is important on permanently frozen soil, like that found in Alaska. 

N. V. Noste is research forester, Forest Fire Research Project, Forestry Sciences Laboratory, Pacific Northwest Forest and Range Experiment Station, USDA Forest Service, College, Alaska. R. M. Percival is fire control officer, Fairbanks District, Bureau of Land Management, Fairbanks, Alaska.

THIS HUMIDITY BUSINESS:

What It Is All About and How It Is Used In Fire Control

Clive M. Countryman

Understanding relative humidity and its relation to fuel moisture makes it a convenient and useful tool in wildland fire control activities.

Relative Humidity Affects Dead Fuels

In the absence of rain, the amount of moisture in dead fuels is controlled to a large degree by the humidity and temperature of the air immediately surrounding the fuel.

On clear days with light winds, the ground surface and the fuels on it become quite hot. It is not unusual for surface temperature to reach 160° to 165° F. when air temperature measured in a standard instru-

Clive M. Countryman is a specialist in fire behavior at the Pacific Southwest Forest and Range Station, Riverside, Calif.

ment shelter nearby is only 80° to 90° F. Close to the hot ground surface, the air also becomes warm and the relative humidity considerably less than that of air only a short distance above the ground. In open areas during the summer, the moisture content of small surface fuels may be only about one-half that of fuels exposed a foot above the surface.

Nights Are Moister

At night the situation can be reversed. The ground surface becomes cold first and cools the air close to it, raising its relative humidity. This condition in turn increases the fuel moisture so that the surface fuels at night may have a higher moisture content than fuels above the surface.

Thus, any condition that results in an air temperature near

the fuel that is different from air temperature measured elsewhere also results in a different relative humidity and fuel moisture.

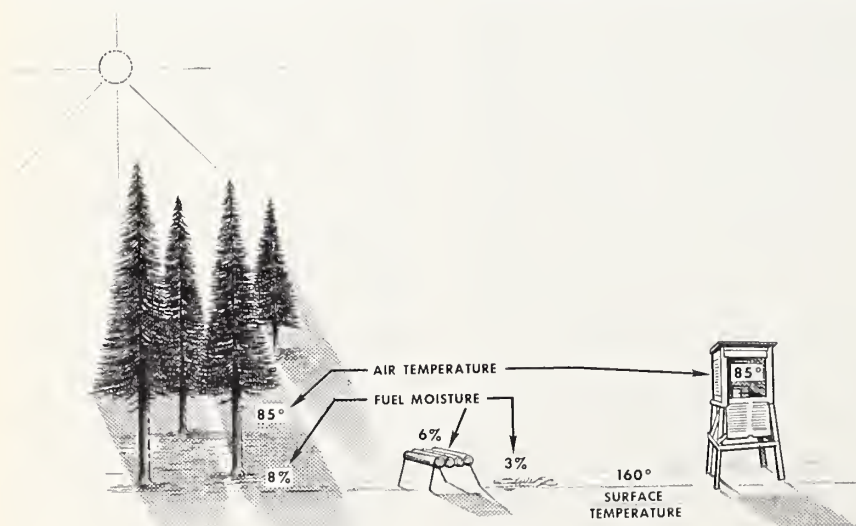
In deep canyons, as compared with exposed slopes, or timbered areas, as compared with open areas, significant temperature and relative humidity differences can be expected.

Fine Fuels Adjust Quickly

Fine fuels with a large surface area compared with their volume, such as grass, leaves, and small twigs, can reach their equilibrium moisture content in a few minutes, but large limbs and logs take a long time. Limbwood 2 inches in diameter may require up to 4 days at a constant relative humidity and temperature to reach equilibrium; logs may require weeks or even months. Since relative humidity is usually continuously changing, the actual fuel moisture lags behind the equilibrium moisture. The amount of this lag depends on how fast the relative humidity is changing, the size of the fuel, and how well the air can circulate around the fuel: loosely arranged, well aerated fuels will have moisture contents nearer equilibrium values than more compact fuel beds.

Relative Humidity Guides a Burnout

Suppose a division boss on a



large fire has the responsibility for constructing and burning out a fireline down a spur ridge and along a canyon bottom. The fireline ranges from 2,500 to 4,000 feet elevation. The plan is to construct the line during the day and to fire it out at night when cooler temperatures and higher humidity will lessen the chance of fire escape during the burning-out operation.

Records Kept

The winds are light, varying from 6 to 10 miles per hour. Throughout the morning the division boss has been recording temperature and humidity with a sling psychrometer on both the ridge and canyon bottom line locations. He has noted that the canyon bottom air has been somewhat cooler and the humidity higher than on the ridge. He attributes these differences to the taller vegetation and small amounts of water in the nearly dry stream bed of the canyon.

By midafternoon the temperature on the ridge is 90° F. and the relative humidity 15 percent—about what the fire weather forecast indicated for the fire area. But at about the same time, the temperature in the canyon bottom is 84° and the humidity 25 percent. The division boss receives a night fire weather forecast which predicts that by 0200 hours the temperature will drop to 60° to 65° and

the humidity will rise to 35 to 40 percent. Wind will be slight.

These conditions will not interfere with burning out the ridge line, but the division boss is concerned about the canyon bottom line.

Dewpoint Is Indicator

Consulting his tables on relative humidity and dewpoint, the division boss finds that a relative humidity of 15 percent and a temperature of 90° indicate the dewpoint is 37° while a temperature of 84° and a humidity of 25 percent give a dewpoint of 45°. The night temperature and relative humidity forecasted also give a dewpoint of 37°, indicating the fire weather forecaster does not expect a change in the air mass. If the temperature in the canyon bottom drops to the forecast of 60°, the division boss finds from his tables that the relative humidity will be between 48 and 55 percent because of the higher dewpoint in this location. At this humidity, the burning conditions are likely to be marginal.

But the division boss also knows that because of cold air drainage into the canyon, the temperature there is likely to be considerably colder—probably as much as 10°. If the temperature drops to 50° or 55°, the relative humidity will range from 69 to 84 percent—too high for successful burning.

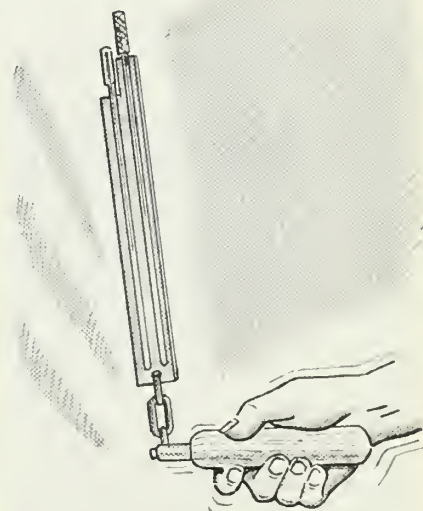
How To Burn Decided

The division boss decides he must complete the burning operation early in the evening if it is to be successful. He then arranges for enough crews to complete the job within the time limits.

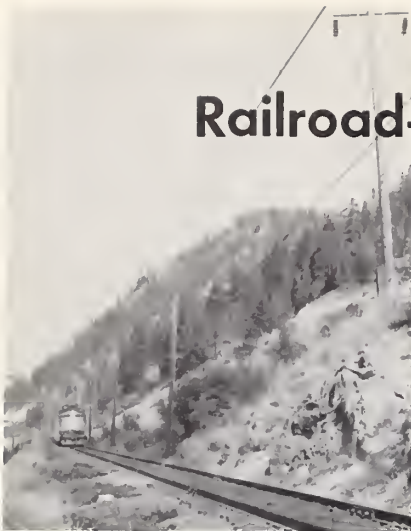
Relative Humidity Utilization Is Simple

Thus, with only a sling psychrometer and a set of relative humidity and dewpoint tables, the fire weather forecast can be localized to fit a specific fireline situation.

This article is adapted from a 1971 Pacific Southwest Forest and Range Experiment Station publication, which is, unfortunately, out of print. 



SLING PSYCHROMETER



Railroads are responsible for starting thousands of fires each year.

Railroad-caused Fires:

What Starts Them What Keeps Them Going

Floyd R. Cowles

A study of fires along two railroad right-of-ways in Region 1 reveals brakeshoes as the leading cause. The study also stresses proper upkeep of right-of-ways as the best way to prevent railroad-caused fires.

Approximately 400 railroad-caused fires occurred along the two study areas during the 1960-1969 period. The Forest Service took suppression action on approximately 20 percent of them. The remainder were suppressed entirely by railroad employees and were not reported by the Forest Service as statistical fires.

Brakeshoes were the leading cause of fires along these study areas. Other fire starters included: exhaust carbon sparks, right-of-way burning, journal boxes, and track repairs.

Fire occurrence was concentrated in areas of heavy braking. For example, 75 percent of one railroad's fires reported by the Forest Service occurred within an area 1 mile east to 1 mile

west of six restricted speed zones. Thirteen brakeshoe fires by another railroad were suppressed (1967-1969) within a 4.5-mile stretch near Superior, Mont.

Causes of Fires Are Many Hot Brakeshoes Are a Hazard

When brakeshoes are pressed against steel railroad wheels, considerable heat is generated. Occasionally hot brakeshoe fragments break off and start fires when fuel and weather conditions are right. These fragments vary from paper-thin pieces, less than an inch in length, to chunks several inches long. Their bluish color indicates they have been heated to temperatures exceeding 1000° F. Pieces of metal of this mass and temperature are effective ignitors when placed in contact with dry fuels and fanned by the turbulence created by moving trains.

• Composition brakeshoes have been developed and are appearing on newer cars. This type brakeshoe holds promise because it does not fragment as easily as cast iron brakeshoes,

and it does not retain as much heat.

Exhaust Carbon Particles¹ Burn

Carbon is produced in the combustion process. Under normal operating conditions (when an engine is running fast with a moderate load and ideal fuel-air mixtures) relatively little carbon residue is produced. However, four conditions promote buildup of excessive carbon:

1. When speed is suddenly increased after engines have been idling for some time.
2. Wherever there are grades and more power or speed is needed.
3. When engines have operated for many hours without proper maintenance and cleaning.
4. When water leaks or other engine malfunctions occur.

Burning carbon particles can be expelled from engine stacks onto adjacent fuels under any of the conditions listed above. If their mass is such that they

Floyd R. Cowles is a forester with the Division of Fire Control, Missoula, Mont.

¹ See related article, FCN, summer 1971: Exhaust Particles How Many Fires Do They Start?

remain glowing (temperature above 400° F.) long enough to reach the ground, and if fuel and weather conditions are right, fires can result. Carbon particles can be thrown as far as 40 to 50 feet.

- In August, 1969, a railroad started using a fuel additive that reduces carbon buildup in engines. Because the company claims that the number of carbon exhaust fires has materially decreased since introduction of this additive, this practice looks promising.

Journal (Hot Boxes) Overheat

The ends of many railroad wheel axles rest in a lubricated bearing called a journal box. These bearings are lubricated by a rag (wick) which furnishes oil to the bearing. Malfunctions can cause a bearing to overheat and, on occasion, start fires.

- Railroads are replacing journal boxes with roller bearings, thus reducing this hazard.

Truck Repairs (Grinding and Welding) Spark Fires

Rails are in constant need of

grinding and welding to keep them smooth and properly fastened together. Sparks from welding and grinding operations are potential ignitors but caused only one fire in the study areas during the 1960-1969 period.

- During grinding and welding operations, maintenance crews should post a lookout to watch for fire starts and thoroughly check for fires before the crew moves to a new location.

Right-of-Way Climate Fosters Fires

For a number of reasons, right-of-ways invite and sustain fires. Railroad rights-of-way are necessarily long, narrow openings in the surrounding vegetation. They are generally at least 100 feet wide. In timbered areas, this treeless swath creates a special micro-climate. Shade is removed and wind movement is altered. The addition of steel rails, rock ballast and black ties causes an increase in thermal radiation. Temperatures are usually higher and humidities lower than in adjacent areas. Wind movement

is sometimes increased, particularly if tracks parallel prevailing winds.

Temperatures along the rights-of-way are 1 to 3 degrees warmer and humidities 1 to 3 percent lower than those at the respective district weather stations.

Fuels in these micro-climates are thus usually dryer than fuels in adjacent forested areas. If winds parallel the right-of-way, some tunneling occurs, promoting faster fire front movement. *Since the micro-climate cannot be changed, the only remedy to rights-of-way fires is fuel modification.*

Fuel Modification Is the Answer Fuel Break Construction and Maintenance Lowers Hazard

Once a fuel break is constructed (as close to the tracks as is practical) annual maintenance is usually necessary. This usually consists of dozing off any vegetative growth. Since most

Three brokeshoe slough fragments are visible in this photo. Triangles point to two of these fragments. This slough material originates from both brokeshoes and track steel. New fragments are shiny and bluish in color because of heating, but they rust very quickly.

These miscellaneous brokeshoe fragments and brokeshoe slough material were found along the right-of-way adjacent to these ties.





A fuel break has been ploughed between track and highway (note berm, broken ground, in left foreground). River and highway serve as firebreaks.

exhaust fires occur within 50 feet of the track, breaks do not need to be constructed much beyond this distance unless topographic or other factors influence construction.

Chemical Spraying Puts Damper on Fires

The spraying of herbicides, soil sterilants, or both is quite effective in eliminating vegetation from the rights-of-way. Sections of the study area that had been sprayed recently were noticeably freer of vegetation than sections not sprayed.

The problems with spraying are: (1) it is costly, and (2) growing public resentment against the use of chemicals for vegetation control. Nevertheless, spraying is a good fire prevention tool, and its use should be continued where approved.

If spraying is necessary to protect adjoining areas from fire, the public should be informed. The danger of pollution from right-of-way spraying is small because of the relatively little amounts of chemical used and the length of time between applications. Right-of-way spraying is not like crop spraying, where, if irrigation is used,

waters carry the chemicals into streams.

It may be found that if spraying is repeated several years in a row, it will inhibit growth enough so that annual spraying will not be necessary.

Right-of-Way Burning Cheap and Effective

Burning is used to eliminate hazardous fuels along the right-of-way. It is a relatively cheap method and accomplishes a fairly complete fireproofing job. A much wider fuel break may be treated by burning than by spraying. In general, burning extends from the rail to the edge of the fuel break.

Burning should be started in the spring, as soon as the previous year's accumulation of fuels is adequately dry. This is a good time to burn, because the soil and lower layers of duff are still moist enough to discourage deep burning and less mop-up is needed.

Burning can also be done later in July, after the cheat grass matures. Burning then is effective in eliminating both current and previous year's fuel accumulations. Greater control of the fire is necessary in July,

however, as fuels are dryer and the threat of escaped fires is greater. A more complete job of mop-up is usually necessary with July burning.

Railroad right-of-way burning problems are not insurmountable. The Forest Service and the railroads have a big job in selling the need for this burning to the public and to State air quality people. The public needs to know that wild-fires pollute the atmosphere much more than prescribed fires. If railroad companies do not burn old ties and burn only lighter fuels (brush, grass, and weeds) there should be little threat to air quality. This burning should be done on days when the atmosphere is unstable and smoke disperses quickly.

You Can Get Study Results

While this study was made on certain sections of track, its results provide general insights into railway fire prevention problems.

Copies of the right-of-way fires report may be obtained from the Division of Fire Control, USDA Forest Service, Federal Building, Missoula, Mont. 59801. 

The right-of-way adjacent to the ballast area has been treated with soil sterilant chemicals.



A Supervisor's Office Coordinating Organization For Multiple Large Fire Suppression Can Work

D. A. Oliver and R. L. Asher

Set up at the direction of a 1970 task force, Region-6's Supervisor's Office Coordinating Organization (SOCO) was put into action in September 1971 to handle three project fires. SOCO, a unit separate from the local forest dispatching operation, was successful, saving time and money as well as reducing confusion.

Following the 1970 fire catastrophe in Northern Washington, a task force was appointed to develop plans for fire coordinating organizations at the Supervisor and Regional Forester levels. A preliminary plan for these organizations was circulated in the spring of 1971 and Region 6 prepared to try the system if major fires developed.

Preplanning Pays

About September 12, east wind conditions started developing over the Cascades in Oregon and Washington. Some slash had been burned in several of the Cascade Forests, but these burns had been well mopped up before the winds began.

The morning of September 16, winds began to increase and

during the day reached peaks of 60 miles per hour. A number of mopped up slash fires started to show life. The Skyhook Fire, which started in an active logging operation on the Mt. Hood National Forest, spotted ahead several miles, resulting in two campaign fires. Several slash burns in close proximity on that same Forest also grew out of control and resulted in another campaign fire. Almost 3,000 men were deployed in the suppression effort on the Forest. The fires consumed almost 5,000 acres of timber land during the next 8 days.

By late afternoon of September 17, a Supervisor's Office Coordinating Organization (SOCO) was set up at the Mt. Hood Forest headquarters to handle the multiple fire situation which involved three separate project fire organizations (see SOCO TEAM chart).

At the onset, the Supervisor's Office Coordinating Organization assigned a separate dispatcher to each fire team. All dispatching communications were transmitted between base fire camp and the assigned dispatcher for that particular fire.

The SOCO Coordinator, the Mt. Hood Fire Staff officer, headed up the overall organization for the Forest Supervisor. It was his responsibility to co-

ordinate and assign priorities for manpower, supplies, equipment, and aircraft to effectively utilize all available resources.

Logistic Officers Supervise Dispatching

The logistics officers, one each for day and night shift, were responsible for the supervision of all dispatching activity and worked under the direction of the SOCO Coordinator.

The assigned dispatcher for each fire team worked under the direction of the Logistics Officer, who had the following responsibilities:

1. Receiving fire orders for manpower, supplies, equipment, and aircraft.
2. Screening orders for completion.
3. Advising on availability and estimated delivery time.
4. Separating orders into manpower, supplies, equipment, or aircraft.
5. Channeling the order to the appropriate functional dispatcher (manpower, supplies and transportation, and aircraft) for action.
6. Following up on orders placed.

SOCO Needs Room

The Mt. Hood SOCO was in-

D. A. Oliver is assistant regional dispatcher, Pacific Northwest Region. R. L. Asher is forest dispatcher, Winema National Forest.

stalled in a 20-foot by 40-foot double wide trailer unit (see general plan: Logistics Team Concept). The aircraft dispatcher operated in the regular Forest Dispatcher's Office due to the location of existing radio communication equipment.

Adequate space is essential, because the SOCO team requires a large working area which should be physically separated from the local forest dispatching operation. The regular forest dispatcher should be able to

operate independently on routine forest business and activities.

A "Hot Line" telephone was installed to provide direct communications between the SOCO and the Regional Dispatching Office. This saved time and reduced confusion.

SOCO Succeeds

SOCO worked very well in this multiple fire situation. With all the dispatchers working under one organization, it was

easier for the logistics officer to carry out the priorities that had been established, and to make sure that all manpower, supplies, and equipment were fully utilized. For instance, if one fire camp had too many frozen meals and another was ordering food, the surplus meals could be diverted to the camp in need. This function saved time and money.

Special Teams Assist

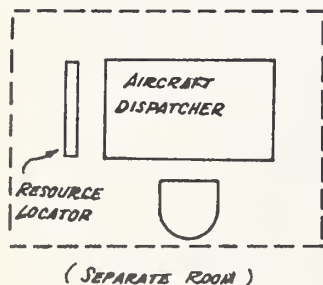
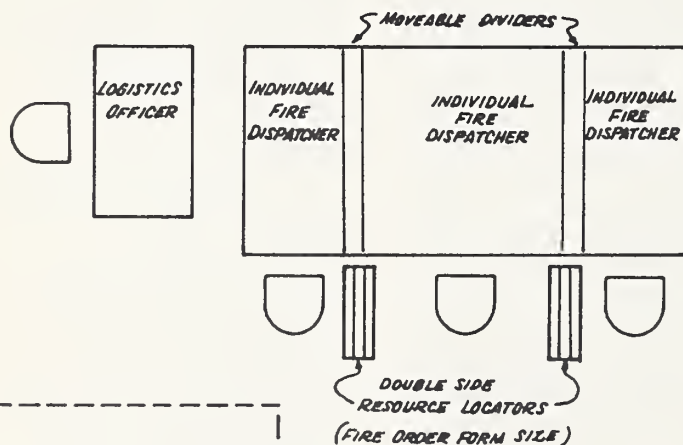
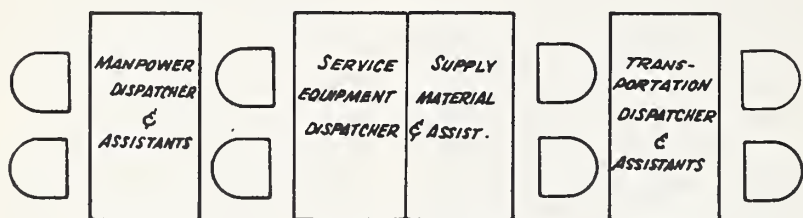
During the time of the manpower buildup, a Casual Recruitment Team was added to SOCO. The duty of this team was to recruit and to train casuals for mopup. Although these crews were hastily recruited and trained, they performed very well on the fires. The one-day training course included fire control fundamentals, mop-up techniques, helicopter procedures, use of tools, and safety. Instructors were from adjacent forests.

When control of the fires was in sight, a Demobilization Team was organized to provide transportation for released crews and overhead. A Demobilization Center was established at Portland AFB. The air base could accommodate large transport aircraft which were needed for transportation of Southwest Indians and other out-of-Region crews.

Problems Few

Problems in logistics were greatly reduced by the SOCO organization. Many of the problems that did arise were due to the SOCO concept being new and a lack of understanding between the fire team and the logistics team. Many of them can

LOGISTICS TEAM CONCEPT FOR MULTIPLE FIRE SUPPRESSION



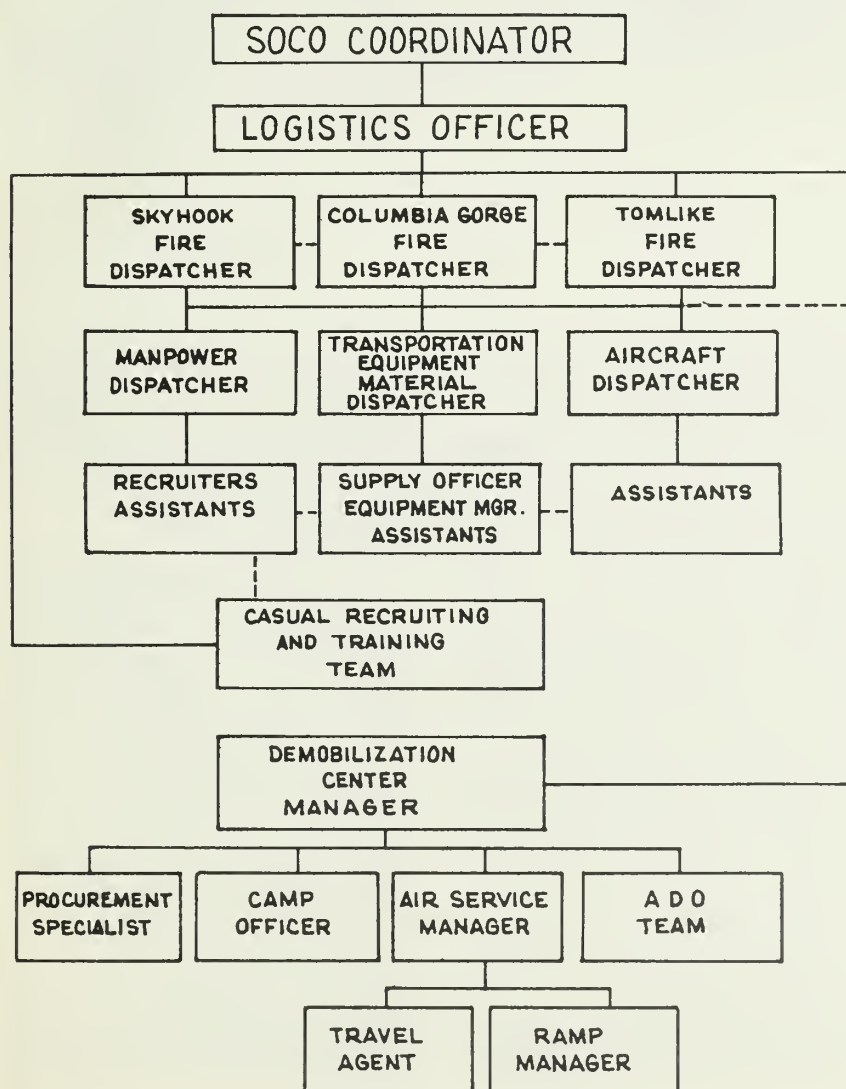
be solved through providing better instructions, model plans, and fire overhead training.

It was also felt the SOCO team should have been organized at the end of the first burning period.

The SOCO concept will be incorporated into Top Overhead Training Lesson Plans and simulated exercises for the 1972 fire season in Region 6. **△**

Chart of the Supervisor's Office Coordinating Organization (SOCO). The general arrangement of SOCO workers in a double-trailer unit.

SOCO TEAM



Tell Us Your Story

What do we want? Articles about communications, equipment and supplies, chemicals, fuel modification, prevention, pre-suppression, suppression, training, and weather.

Any length article, up to 3,000 words, is welcome. Use any available editorial assistance (For F.S. authors in the Regions, the Di-

vision of I & E at Regional Headquarters can help.). Read your article to a friend. W.O. will provide final review and can provide rewrite assistance.

Preparing Your Article

The title of your article should be typed in capitals at the top of the first page. Directly under the title, give author's name, position, and organization.

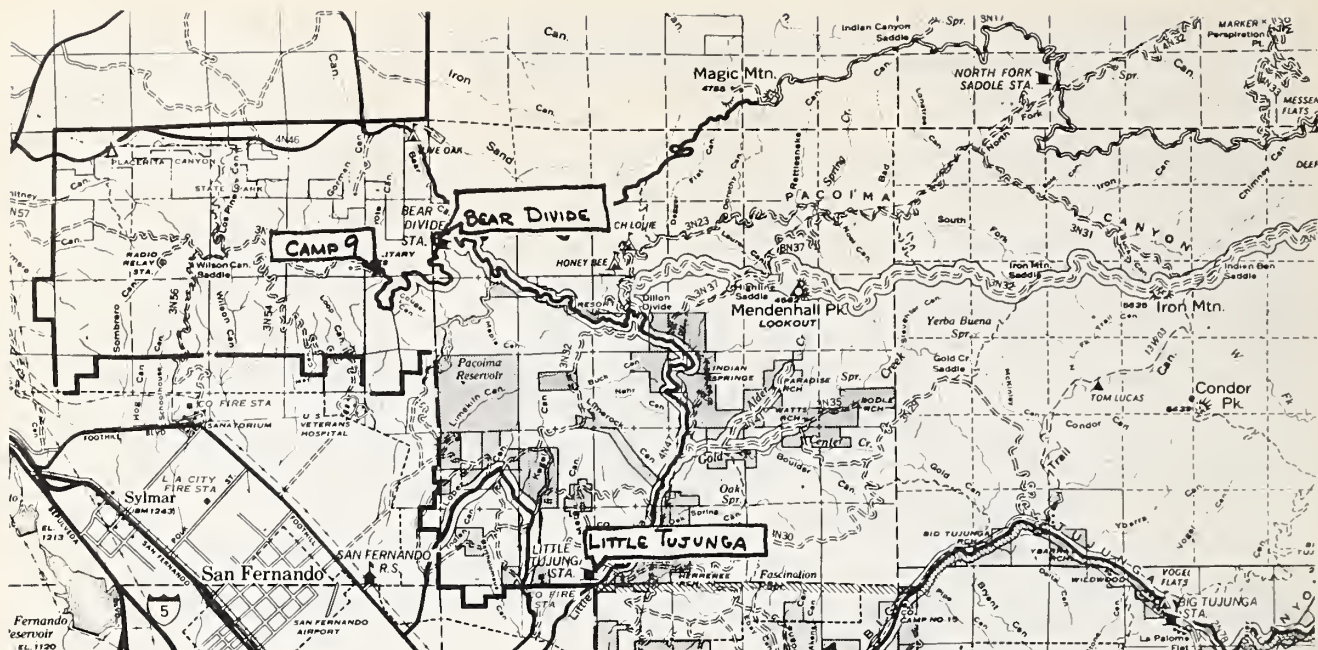
Double- or triple-space your article and allow generous side margins.

You are encouraged to include illustrations with your copy. Drawings or photographs should have clear detail and tell a story. Glossy prints or India ink line drawings are preferred.

Please type captions for illustrations immediately following the paragraph in the text where the illustration is first mentioned. Separate the caption from the text by lines both above and below. Label illustrations "figures" and number consecutively. Drawings should be made with page proportions in mind and lettered to permit reduction. In mailing, illustrations should be placed between cardboards held together with rubber bands; don't use paper clips.

Where to Send Your Article

Please send your article to Director, Division of Fire Control, Forest Service, U.S. Department of Agriculture, Washington, D.C. 20250. **△**



Angeles National Forest showing heliport locations.

County and National Forest Share Helicopter

John I. Bowser

During the 1970 fire season the Angeles National Forest and the Los Angeles County Fire Department utilized a Bell 205 A-1 helicopter under a co-operative agreement. This type of arrangement is a first for the Forest Service in Region 5 and may be a first for the country.

The 15-passenger helicopter, paid for in part by the Forest Service, was purchased by the County Fire Department. It was flown by County pilots and maintained by County mechanics. The ground support crew of helitack crew were Forest Service personnel.

One base of operation was the Forest Service heliport at the

John I. Bowser is a helitack squad leader, Lassen N.F.

Bear Divide station; the other was the County heliport, Camp 9, on Los Pinetos Mountain. Camp 9 is an abandoned Niki site operated under permit from the Forest Service; it housed three 10-man initial attack crews. The Bear Divide station housed the 3-man helitack crew as well as a 5-man tanker crew and one Forest Service patrolman. Both bases, which are located about a mile from each other, are within the boundary of the Angeles National Forest, Tujunga District (see map).

Standby Alternates

The 205 A-1 alternated standby daily between Los Pinetos and Bear Divide.

A typical fire, the Leona Fire, began on October 10, 1971. It

was approximately 1½ miles outside the Forest's boundary but within the mutual aid area of Los Angeles County.

Helicopter Saves Time

The helicopter was dispatched by the County dispatcher from Los Pinetos. Ten men, besides the Forest Service helitack crew consisting of squad leader and crewmen, were boarded. After the fire crew and helitack crewmen off-loaded at the fire, the helicopter, with the squad leader aboard, left the fire scene to get the second fire crew from Los Pinetos.

After the second crew was enroute to the fire, the squad leader contacted the Little Tujunga Hot Shots who were responding to the fire via ground



Bell 205A-1 used cooperatively by Forest Service and Los Angeles County.

transportation and set up by radio a rendezvous location. Once the second crew off-loaded at the fire's edge, the helicopter proceeded to the rendezvous and transported the Hot Shot crew to the fire. Eighty-five air miles were flown in 56 minutes. This includes flying and ground time for loading crews and tools.

Utilization Goes Smoothly

Fifty-six missions were flown with 548 sorties. 3,356 men and 108,225 pounds of cargo were carried between August 6, 1970

and November 24, 1970. A total of 98.1 hours were flown on fire assignments for the two agencies.

This operation ran very smoothly with no major problems in spite of the fact that both fire fighting agencies are separate and highly organized.

In addition to the three County crews mentioned above, the Forest Service maintained a 20-man Hot Shot crew at the Little Tujunga station. Since this was a project and fire crew, most of their time was spent on projects away from any base of operations. Their location was known to the Forest Service helitack crew at all times, and rendezvous could be made when the crew was needed.

Both Agencies Dispatch

The helicopter was on fire standby at either base for all fires in Los Angeles County (which includes the Angeles N.F.). Both agencies were able to dispatch the helicopter. Upon dispatch the other agency was



Crew loading tools before boarding helicopter.

notified of the fire assignment by the helitack personnel. The nearest available fire crew was boarded and flown to the fire, regardless of whether it was a Forest Service crew on a County fire or a County crew on a Forest Service fire.

Since a retardant drop tank, although being developed, was unavailable for the '70 season, transportation of men, equipment and supplies, and reconnaissance were the only jobs carried out. △

Proceedings of Symposium On Prescribed Burning Are Available

April 1971 more than 400 people attended a symposium in Charleston, S. C., to discuss the environmental impacts of prescribed burning on the forests of the Southeastern Coastal Plain. Copies of the proceedings of this symposium are now available free of charge.

The 160-page proceedings contains papers on the effects of prescribed fire on vegetation, timber species, wildlife and range habitats; and on the physical and chemical properties and the microbial and faunal populations of soils. The impact

on aesthetic and recreational values—the landscape, outdoor recreation, and tourism—and the influence of public pressures and legislative action was also covered. Finally, the broad environmental aspects were discussed from the ecologist's view of prescribed burning and its impact on the forest ecosystem.

Single copies of the proceedings are available free of charge as long as the supply lasts. Write to: Director, Southeastern Forest Experiment Station, Post Office Box 2570, Asheville, N. C. 28802.

Environment Is Emphasis Of Symposium

The United States hosted an international symposium on "Fire In the Environment" held in Denver, Colo., May 2-4, 1972. Sponsored by the North American Forestry Commission. Fire Management Study Group, speakers from Mexico, Canada, Australia, and the United States participated.

For further information contact Mr. W. R. Tikkala, Symposium General Chairman, Forest Service, U.S. Department of Agriculture, Washington, D.C. 20250. △

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A Look At What Killed 12,200 People Last Year

What with all the efforts to do something about "bettering our environment"—which is really a catchphrase for making our surroundings safer and healthier—there is a tendency to overlook one of the oldest people-killers known to man: fire. Somehow, maybe because it's too obvious to become a trendy environmental topic, public concern about fire safety has never amounted to much more than a set of seasonal campaigns that draw token civic support.

But last year, fire killed 12,200 people in the United States—and about one-fourth of these victims were children. The total also includes 210 firefighters. The property damage figures are shocking, too: an estimated \$2.845 billion caused by the more than 2½ million fires in 1971. Of this total, about \$2.3 billion represents damage to buildings and their contents; the rest is attributed to forest fires and damage to aircraft, ships and motor vehicles. The President's National Commission on Fire Prevention and Control, which compiled these



statistics, says the principal causes of building damage were defective, misused and overloaded electrical wiring and equipment; defective or overheated heating and cooking equipment; and careless use of smoking materials.

Obviously, safety slogans haven't done the job, and new ways must be found to improve the nation's ability to prevent, detect and control fire. This is the challenge currently being undertaken by the presidential commission, which will begin a series of public hearings on the subject here this morning at the old Senate office building. The commission, which includes Cabinet members, engineers, insurance executives, experts in firefighting and four advisory members from Congress, is doing a two-year study of the nation's fire problems and will submit a report of its findings and recommendations in June, 1973.

While no simple solutions are likely to spring forth from the public hearings, this serious attempt to come up with some new thinking deserves public attention and support, as a significant—and extremely difficult—examination of an age-old environmental problem. 

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WINTER 1971-72 • VOL. 33, NO. 1

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FIRE CONTROL NOTES

An international quarterly periodical devoted to forest fire control

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Wilderness Fires Allowed To Burn More Naturally

David F. Aldrich, and
Robert W. Mutch

Firehawks often confused us . . . by deliberately setting fire to grass and bushland to assist their scavenging. I have seen a hawk pick up a smouldering stick in its claws and drop it in a fresh patch of dry grass half-a-mile away, then wait with its mates for the mad exodus of scorched and frightened rodents and reptiles. When that area was burnt out the process was repeated elsewhere.

The observation about firehawks in Australia from Lockwood's book, *I, The Aboriginal*, may appear far removed geographically from the fire study in the Selway-Bitterroot Wilderness. But this account does provide a dynamic expression of interrelationships among fire, flora, and fauna. In our own country, and drawing from a more passive example than the firehawk, we now recognize the role that fire plays in maintaining Kirtland warbler habitat in

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The upper end of the White Cap Creek drainage of Idaho's Selway River in the Selway-Bitterroot Wilderness. White Cap Creek is a 66,000 acre study area in which Forest Service Region 1 is studying fire's role in wilderness in order to establish guidelines to assist land managers to prepare prescriptions to allow wilderness fire to more nearly assume a natural role.

Michigan. Furthermore, a recent study in California describes a considerable diversity in bird species due to the variety of habitats that resulted from the Donner Ridge fire.¹

Not All for the Birds

But what do firehawks and Kirtland warblers and bird species diversity in California have to do with wilderness management and with Region 1's management study? Certainly these examples are representative of fire-perpetuated food chains and habitats; and if birds are thus affected, what of other living forms up and down the food chain? The Wilderness Act of 1964 directs us to consider such questions in the administration of the National Wilderness Preservation System:

An area of wilderness is further defined to mean in this Act an area of undeveloped Federal land retaining its primeval character and influence, without permanent improvements or human habitation, which is protected and managed so as to preserve its natural conditions and which generally appears to have been affected primarily by the forces of nature, with the imprint of man's work substantially unnoticeable; . . .

Protection from Man Needed

Ironically, it is our traditional approach to protection that is being questioned today with regard to management of national

¹ Carl E. Bock and James F. Lynch. Breeding bird populations of burned and unburned conifer forest in the Sierra Nevada. *Condor* 72(2): 182-189, 1970.



A view of the upper White Cap Creek showing areas of relatively low production of vegetation. This and the previous photo present graphically a variety of opportunities and challenges for fire management.

park and wildernesses. Rather than just protecting these wildlands from fire, insects, and disease, we are beginning to discuss strategies to protect these areas from ourselves and man-centered goals.

Fire To Play Its Natural Role

Participants in Region 1's Wilderness Workshop in Missoula in 1970 recognized that fire control as practiced today is a most unnatural action in wildernesses. The group contributed to a new Regional policy that "fire will be allowed to more nearly play its natural role" in wilderness. Implementing this policy is contingent on an approved plan describing fire management directions for the wilderness. Region 1 wilderness fire policy points up that the influence of fire on vegetation diversity in the northern Rocky Mountains is being recognized administratively. This is an interesting departure from our traditional approach to fire control, but not a departure without precedent. In 1963 the Leopold Committee said that "reluctance

to undertake biotic management can never lead to realistic preservation of primitive America, most of which supported successional communities that were maintained by fires, floods, hurricanes, and other natural forces."

A Study Evolved

The Wilderness Fire Management Study is an outgrowth of the Wilderness Workshop in Missoula. Specific objectives of the study are to:

1. Develop inventory methods that relate fire management to the wilderness resource.
2. Determine relationships between fire and wilderness ecosystems.
3. Develop analytical procedures to aid in determining strategies for a more natural regime of fire in wilderness.

The 66,000-acre White Cap Creek drainage in the Selway-Bitterroot Wilderness, Bitterroot National Forest, was designated as the primary study area. This drainage offers a variety of biological and physical conditions for study—from ponderosa pine savannas on the western edge of the study area to stands of sub-alpine larch along the

National Forest Administration and the Intermountain Forest and Range Experiment Station are conducting the Wilderness Fire Management Study, in the Selway-Bitterroot Wilderness, Bitterroot National Forest, Region 1, to assist in implementing new Regional policy that "in wilderness, fire will be allowed to more nearly play its natural role".²

rocky crest of the Bitterroot Mountains in the eastern portion of the drainage. Dr. James Habeck, plant ecologist at the University of Montana, is participating in the study by conducting a reconnaissance of plant relationships throughout the Selway-Bitterroot Wilderness.

Several studies are providing the basic information required to determine when and how to return to a more natural sequence of fire incidence: geology, landform, soil, and hydrologic analysis; vegetation; fire history; fuel appraisal; and fish habitat. Vegetation analysis includes a description of the potential vegetation, successional studies in low-elevation and high-elevation forest zones, and the phytosociological reconnaissance. Fire history is being determined from existing records and techniques of dendrochronology. Fuel appraisal techniques, developed for fire planning and fire-danger rating are also being applied. This appraisal will provide estimates on fire growth and fire-intensity potential in the White Cap drainage.

These studies started during

² USDA Forest Service Manual No. 5102, R-1 Supplement 35, April 1970.

the 1971 field season. Preliminary guidelines will be proposed in time to begin phases of wilderness fire management in Region 1 during the 1972 field season. Guidelines will be refined as experience and new information are obtained. At no time will the guidelines provide a mechanical procedure for obtaining "the answer." Skill and good judgment will be essential to implementation of guidelines and policy.

What Else Is Going on

Let's look at other operational efforts to return fire to the landscapes of wildernesses and national parks: The Rincon fire occurred in the Gila Wilderness in New Mexico in August 1970. The decision to delay action on this fire was in accordance with Region 3 fire-control policy, which recognizes that action to suppress a wildfire may be delayed under specified conditions. Fire growth continued over 32 days with limited suppression action, reaching a final size of about 900 acres. Smoke from this fire was visible to most travelers at the nearby Gila Visitor Center and reports of the fire numbered in the hundreds. Explanations by Visitor

Center personnel of the role of fire in wilderness were accepted almost without exception.³

The fire program in Sequoia and Kings Canyon National Parks in California consists of two fire control strategies on park lands.⁴ A zone of approximately 553,000 acres above the 8,500-foot contour has been designated as a noncontrol area. All lightning fires within this zone are allowed to run their course with little or no interference by man. In 1970 the largest fire in this zone was 452 acres. The remainder of fires were 20 acres or less in size. In the more productive forest zones at lower elevations fire is being returned to the sequoia groves through prescribed burning. Sequoia and Kings Canyon have aggressively pursued education programs regarding these fire policies, and public reaction has generally been favorable.

Fire Fits the Environment

While we have traditionally

³ E. L. McCutchen. Rincon burn report. 1970. (Unpublished material on file at Northern Forest Fire Laboratory, Missoula, Mont.)

⁴ Bruce Kilgore. Restoring fire to the Sequoias. Nat. Parks and Conserv. 44(277): 16-22, 1970.

viewed fire largely as a negative and destructive force, we need to develop the tolerance to view fire as an environmental factor which has contributed to ecosystem diversity over evolutionary periods of time. This changing attitude does not mean that we will relax any of our fire prevention efforts or completely turn our backs to naturally occurring fires in areas of wilderness. In the future each fire should either be aggressively fought on every acre or simply let run in wildernesses. The more difficult job for fire management specialists, and the more challenging job, is to work hard at understanding the functioning of ecosystems so that we can prescribe a biologically defensible balance between fire protection and fire incidence. The Wilderness Fire Study, along with the studies in the Boundary Waters Canoe Area⁵, will provide inventory and planning tools needed by managers to provide for a more natural regime of fire throughout the Wilderness Preservation System. 

⁵ M. L. Heinselman. Diary of the canoe country's landscape. Naturalist 20(1): 5-13, 1970.

A view of the lower reaches of White Cap Creek showing land capable of producing relatively large volumes of vegetation. Forest cover types represented range from ponderosa pine and Douglas-fir on the south slopes to Douglas-fir, grand fir, lodgepole pine, and sub alpine fir on the other slopes.



Portable TV Camera-Videotape System Used For Fire Control *in Forests*

John D. Dell and Raymond T. Steiger

Use of a portable TV camera-videotape system by the fire behavior-intelligence team in a multifire situation on the Okanogan National Forest in July 1970 is discussed. The authors describe the complexity of the fire situation and the use of the video system. They also discuss new developments in videotape equipment and potential fire control uses for these systems.

During the 1970 fire season in the Pacific Northwest Region (Region 6), the authors had an opportunity to work together in exploring a relatively new technique for gathering important fire behavior and intelligence information. We used a compact portable TV camera-videotape system (fig. 1).

On the morning of July 16 an intense, dry lightning storm set 227 fires on Washington's Snoqualmie, Mount Baker, Wenatchee, and Okanogan National Forests. This storm also caused more than 100 fires on National Park, State, and Indian lands. The greatest concentration of fires was on rugged, remote

areas of the Okanogan National Forest in north-central Washington. On the morning of July 17, there were 55 uncontrolled fires, 14 already of project size, that is, requiring outside help.

A prolonged drought, tinder-dry fuel, and steep, rough terrain (much of it inaccessible except by foot, pack animal, or helicopter) combined to make this one of the most serious fire situations in the Region's history. A typical example was the Bunker Hill Fire in the Pasayten Wilderness which burned partly in Canada and was 18 miles from the nearest road in the United States. Another fire, the Hungry Creek, was in such steep terrain that several areas could be reached and controlled only by mountain climbers. On the neighboring Wenatchee National Forest, smokejumpers attacked the Safety Harbor Fire, and followup crews were transported by boat across Lake Chelan. Many other fires burned.

We Needed Information

Determining expected behavior on these fires and gathering accurate intelligence data was extremely difficult because of the many fires, overloaded communication facilities, and differences in fuels and topography on each fire. Even if a fire behavior officer had been at each remote fire, his effectiveness would have



Figure 1.—The battery-powered TV camera and audio-videocorder unit is compact and portable. On the numerous Okanogan fires, videotapes were made several times each day from aircraft with the fire behavior officer narrating key information on each fire as the cameraman recorded it for immediate review-ing at general headquarters.

been limited since he would have had almost no opportunity to consult with a meteorologist at a fire weather mobile unit. Inaccessibility of these fires and limitations on use of helicopters for reconnaissance of fuels and topography would have further restricted his effectiveness. (On two of the more accessible fires, fire behavior officers were assigned. On the 2,080-acre Bunker Hill Fire, a fire behavior officer and a meteorologist with a special portable weather unit¹ were flown in.)

It was immediately apparent that gathering much of the information for the rest of the fires would be done by observation aircraft, from which a coordinating general headquarters (GHQ) fire behavior officer could view all the fires, get back to a headquarters base to consult

¹See: Howard E. Graham. A portable fire weather unit for use on back country fires. *Fire Contr. Notes* 25(3):11, 1964.

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with meteorologists, then relay critical information to the various fire camps and spike camps—either by radio or, as happened in most cases, by dropping messages from aircraft. The GHQ fire behavior officer and the intelligence officer teamed up on aerial reconnaissance flights and reported jointly to the GHQ fire coordinator and plans chief. The information from the report was further relayed to fire bosses on each individual fire that had project potential.

Information Was Videotaped

The Okanogan's information and education specialist, Raymond Steiger, who was serving as public information officer, decided this would be a good time to hire a local cooperator, Mr. Bill Houston, who owns his own portable TV camera and audio-videotape equipment, to record on videotape some of the fire activities for the Forest's historical files. Since the fire behavior-intelligence team was making observation flights two or three times daily, they took Houston with them to film some of the fire action.

The fire behavior officer, John D. Dell, soon realized that this equipment was extremely useful for recording up-to-the-minute progress and behavior of each fire from the aircraft. Instead of taking notes on a number of different fires and trying to piece them together back at GHQ, he quickly developed a sight and sound system of narrating and identifying each fire on the audio portion of the videotape. When the cameraman started to film a fire scene, the fire behavior officer noted the time of observation, name of the fire, and direction of view. He then described the fire's current behavior, expected behavior (based on latest weather briefing), and the top-

ography and fuels in and around the fire as the cameraman filmed it. He also recorded fire intelligence information such as progress of line building, possible control lines, potential helispots, spike camps, and other key information. The videotape was later replayed to the GHQ fire coordinator and his staff.

Visual Orientation Made Available

This system was used effectively also as a means of visually orienting new overhead teams arriving at GHQ for assignment to fires. Many of these people were flown in from other regions and were unfamiliar with local weather, fuels, and terrain. The fire behavior officer met with a number of the teams and, while the fires were being viewed on the TV monitor (fig. 2), explained the general fire situation, characteristics of local weather, topography, fuels, and expected fire behavior. In most cases, these fires had been flown over and taped within the past few hours.

What Did We Use?

The equipment consisted of a

Sony battery-powered, portable (shoulder pack) videocorder and attached hand-held video camera (Model DVK-2400/VCK-2400) with zoom lens, pistol-grip handle, and unidirection microphone and hookup. A playback unit (Model CV-2600) and an 18-inch TV monitor-receiver for viewing the tapes completed the setup (fig. 3). The unit uses 1/2-inch-wide magnetic videotape, which runs at 7 1/2 inches per second and plays for about one-half hour. The tapes require no processing and are playable immediately after recording.

Houston supplies his equipment to the Forest on a contract, rental-agreement basis. He charges \$40 for 1 day of camera-videocorder use plus 2 days of playback unit-TV monitor use. His services, when needed, are paid for on an hourly basis and are not included in the contract rate. The videotapes, which play for about one-half hour, are purchased by the Forest for about \$15 each. Portable videotape recording systems are available from a number of domestic and foreign manufacturers at vari-

Figure 2.—Current fire behavior and intelligence information is played back on the TV monitor for an outgoing fire team at GHQ in order to orient the team to fuels, topography, expected fire behavior, and other key information.





Figure 3.—The equipment used on the Okanogan fires consisted of: (1) A portable videocorder and video camera with microphone hookup, (2) an 18-inch TV monitor-receiver, (3) a playback unit, and (4) 1/2-inch magnetic videotape.

ous prices. Some of them are on Government Services Administration contract lists.

New Equipment Is Now Available

A brief survey of the TV tape recorder market indicates that newer videotape recording systems, much improved over the system used on the Okanogan fires, are now available. The new units will play 1/2-inch tapes recorded on any manufacturer's machines (on older units, tapes were not interchangeable). The new units produce sharper images, with 300-line resolution, compared with 220 lines on the older units. The need for a playback unit (item 3 in fig. 3) is eliminated in most of the new systems. Tapes are played directly from the videocorder into the TV monitor-receiver.

Special features now include stop action, audio that can be added after recording of video, and an electronic viewfinder in the camera eyepiece that can be used for instant playback to check the tape as soon as it has been recorded. One manufacturer is producing a new cart-

ridge-loading system that will have tapes that record at two-speeds and will have slow-motion capabilities. Also available are battery-operated TV monitors for immediate viewing of tapes at remote field locations, such as fire camps, where electric power may not be available. The prices of the new units are comparable with the older model we used. Color systems are not available in portable, lightweight, battery-powered units as yet, but this is the next step in videotape recorder engineering.

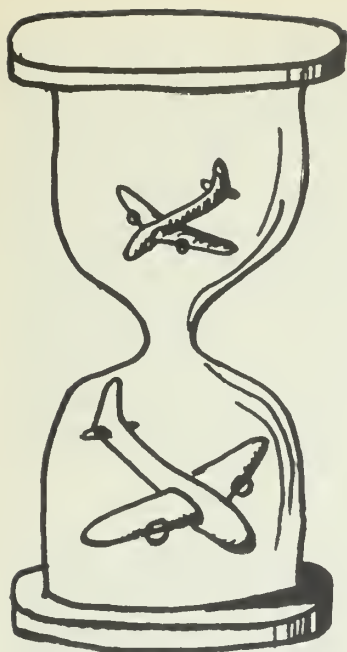
Forest Service Region 6 (Division of Fire Control), Portland, Oreg., recently purchased its own new portable TV camera-videotape system, including two TV monitors, for a total cost of \$2,075. A cadre of technicians has been trained in proper use and care of the equipment, and as needed, these individuals will be dispatched with the equipment to problem fires.

Videotape Has Potential

In this paper we have described some of the special problems encountered by the fire behav-

ior-intelligence team in a critical multifire situation and how a portable TV camera-videotape system was used to improve the effectiveness of this team. We recognize that techniques of using equipment and methods of recording important fire information can be improved. Based on the considerable experience with the system in 1970, we see significant potential for it in fire control work.

In addition to the uses we made of it, this equipment offers a whole new range of possibilities for training programs. To get feedback and review of performance, we see use for the equipment in fire investigation work, damage appraisal, fire reviews, accident investigation, and slash smoke management. We also see use by public information officers in describing current fire situations to press and public. Videotape recording has considerable potential in many other phases of forest management and research work. It is another product of the electronics age that can be used to improve and streamline the complex job of land management. Δ



Time Is Factor In Aircraft Tracking System

Fred E. McBride

[Forest Line[®]
detection]

The Boise Interagency Fire Center (BIFC) now boasts an electrical aircraft tracking system that is easy to use, includes both an "aircraft-due" alert system and closed-circuit TV viewing of the tracker, provides "ready-recall," and, most important of all, incorporates the factor of time.

Keeping close track of aircraft movements is a must for any office controlling aircraft in flight. Most existing tracker systems lack one essential item, "real time;" are bulky; are limited in the number of aircraft they are capable of handling; or do not incorporate "ready-recall." New expensive computer systems incorporate the missing time element but at a cost ranging from \$20,000 to \$100,000!

Time Tamed

BIFC has overcome most of these obstacles by devising a flight tracking board incorporating time with a 24-hour horizontal clock. The clock has a vertical 6-foot pointer (fig. 1).

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The pointer travels horizontally across a magnetic board which is divided into 24 equally spaced hour columns. Thirty-six horizontal lines allow simultaneous tracking of 36 aircraft (fig. 2).

The communicator enters the departure location, destination, and aircraft "N" number (fig. 1B). This information identifies the flight. Placing a magnetic indicator in the "up" position in the appropriate time block shows estimated departure time. Placing a magnetic indicator in the "down" position in the appropriate time block shows the estimated time of arrival.

Any indicator left of the right-hand edge of the clock-driven pointer represents action, corrected if necessary, already happened. Any indicator to the right of the edge represents future action. When the pointer is between two magnetic indicators on one level the elapsed time from takeoff to the present can be determined directly from the horizontal clock.

Alerts Signalled

Time was thus incorporated into a flight tracking system.

However, we felt we needed another item, an alert system.

The alert system we devised is a panel with a series of lights wired to the magnetic board. Each light corresponds to a horizontal line on the board. Each

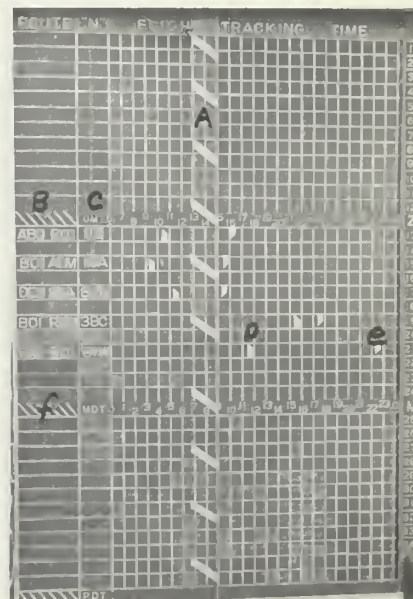


Figure 1.—Overall view of the magnetic aircraft tracking board showing its various components: (A) Clock-driven pointer, (B) route designator column, (C) aircraft identification column, (D) estimated-time-of-departure designator, (E) estimated-time-of-arrival designator, and (F) time designator line.

line has a low DC volt. The clock pointer has the remainder of the circuit necessary to light the light.

Because the pointer and the lines on the board normally do not come in contact with each other, the lights on the panel are usually off. An electrode attached to each magnetic indicator indicates estimated time of arrival (ETA). When the pointer comes in contact with a magnetic arrow, the light is turned on. Through a series of relays, the light stays on until the dispatcher cancels it.

Review Possible

To provide the "ready-recall" mentioned earlier, BIFC has made one further refinement of the flight tracking board. A closed circuit television was installed, which transmits an image of the board to those offices needing to review flight actions. No longer are additional boards nor the men to update them needed.

Time Most Important

More important than the other features of BIFC's aircraft tracking system is the feature of time. Without considering time, tracking is only partly done. Look at your tracking system. Whatever it is, however well it works, does it include time? It should. △



Figure 2.—Pointer drive system (cover removed): A motor driven windlass operates the timing pointer. The motor is a 115 volt A/C electric synchronous motor; the speed is 1-r.p.h.; the motor drive is a .477 in. diameter pulley which acts as a windlass drive drum. One loop of .0018 in. diameter nylon cord is the drive line.

Lit Long Ago,

Mine Fires Still Burn

Paul D. Brohn

To have an uncontrolled fire burning in a forested area since 1884 seems incredible in this age of modern fire fighting techniques. Yet such a fire is burning on the Athens District of the Wayne National Forest in southeastern Ohio.

The fire is in an old, underground coal mine, and for the past 90 years it has burned through several hundred acres of abandoned shafts. It is one of several going mine and waste coal fires in the Athens District. And despite the District's many attempts to put them out, these mine fires continue to burn.

Miners on Strike Light Fires

Coal production was the main industry of the Hocking Valley area of southeastern Ohio during the late 19th and early 20th centuries. Hundreds of underground mines were dug throughout the region. Large portions of the now mined-out areas lie within part of the Wayne National Forest.

During 1884, striking miners in New Straitsville, Ohio, started the fire that has burned the longest in Ohio. Miners set coal cars on fire and pushed them into various mine entrances. Their actions are still being felt whenever a road or house sinks into the ground or a forest fire starts.

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Other mine fires started differently. One near Murray City, Ohio, began shortly after World War II when coal strip miners lit their warming fires too close to an exposed coal seam. Forest fires also touched off some mines by igniting exposed coal seams on unreclaimed strip mines or in abandoned, underground mine entrances. Coal refuse piles in the forest serve as a smoldering source of fires; they catch on fire by spontaneous combustion or from forest fires.

Crevices Create Hazard

The old mines in this area of Ohio are near the surface and are known as drift or horizontal mines. This means the coal vein lies horizontally anywhere from 20 to 100 feet below the ground surface. Mine fires and resulting ground subsidence open fissures, often undetectable, from the old passageways to the surface. Because of the chimney-type draft, flames from fires smoldering in the mine shoot up through fissures as the fires burn under them. When they reach the surface, this eruption of flames ignites dry leaves and other forest vegetation. Fissure eruptions are unpredictable, making each

See MINE, p.14.



Smoke drifting to the surface from a mine fire. Notice how close vegetation is to the hole.

More Accurate Scanner, Faster Aircraft Tested

R. F. Kruckeberg



Figure 1.—Beechcraft B90 King Air. Scanner port is indicated by arrow.

The personnel of Project Fire Scan field tested an improved infrared (IR) [forest fire detection] system in 1970 and found that the equipment could identify and mark latent fires as small as 1 square foot in a forest environment. Approximately half of the fires in the test area were scanned by the airborne equipment and over 50 percent of these were detected.

Now, if you will think back a few years, you will realize that I am not telling you anything new; similar success was reported by Losensky in 1969¹. At that time you learned that an IR system *could* find fires and that these fires could be located accurately. But, you also learned that the target discriminator (TDM) was marking a rather large number of false alarms, some of which were causing suppression crews to lose valu-

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¹ B. John Losensky. An operational test of an infrared fire detection system. USDA Forest Serv. Fire Contr. Notes 30(2): 8-11. 1969.

able time in unsuccessful searches.

Since the 1967 tests, a number of improvements have been made in the IR system. The 1970 flights were designed to (1) test the improvements and (2) to provide answers to questions about operational procedures that might be used during actual fire detection patrol missions.

The major changes in the system were (1) the development of a two-detector receiver that eliminates false alarms by automatically identifying 1-square-foot, 600° C., targets from their much cooler, 0° to 50° C., thermal backgrounds and (2) the installation of the equipment in a pressurized, twin turboprop aircraft (Beechcraft King Air) that could average 230 m.p.h. groundspeed up to 28,000 feet above m.s.l. (mean sea level) (fig. 1).

The test area was in western Montana and northeastern Idaho where there is a high occurrence of fires caused by lightning. This test area covered about 8,000 square miles in the Clearwater, Nezperce, Bitterroot, and Lolo National Forests of Region 1 of the Forest Service. Elevations ranged from 1,300 to 10,211 feet. (Small

parts of the Salmon, Payette, and St. Joe National Forests were also flown over, but the fires detected there are not included in this summary.)

Several flight routes were set up across the area (fig. 2); these consisted of parallel strips having centers 9 miles apart. Flights at 23,000 feet above m.s.l. provided at least 10-mile-wide coverage with some overlap. By alternating between routes 1 and 2 on successive nights, areas of low detection probability near the edge of one strip were given high detection probability by being near the center of the strip on the next night's patrol. Infrared patrol flights were made, supplementing the existing visual detection system which consisted of 57 lookouts and seven patrol planes.

Wildfires Detected and Interpreted Quickly

From July 7 through September 3, 1970, the project flew 41 patrol missions. Most of these were at night and took 4 to 5½ hours to complete. Interpretation of the imagery was done in flight because this would cut down on any delay between detection and reporting time. No problems occurred! Target locations could be relayed by radio to the National Forest concerned

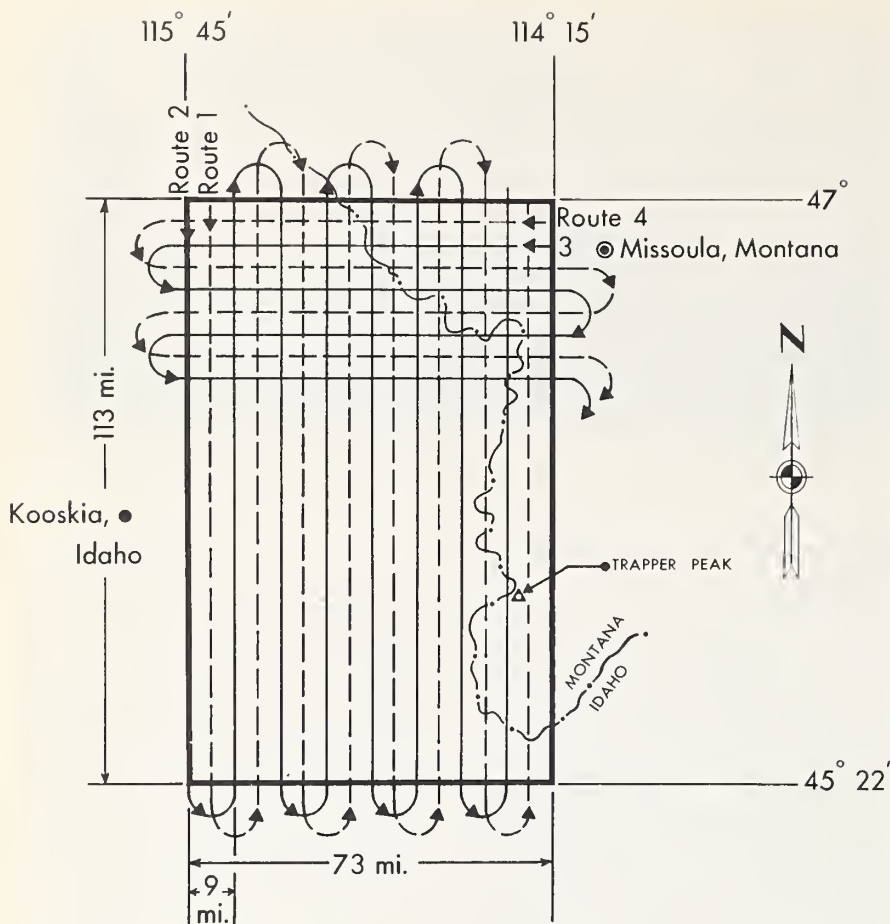


Figure 2.—Layout of the 1970 patrol routes.

at the end of each strip, providing accurate locations within 30 minutes of detection.

Post-season analysis shows 418 fires in the test area during the period of the field test; 12 of these were detected and extinguished while the aircraft was away for a periodic inspection. Of the 406 fires remaining, 203 were detected visually and were out before the IR aircraft had a chance to look at them. This leaves 203 that were burning undetected when the plane passed over. IR identified 103, or approximately 51 percent, of the fires scanned. Of the 100 fires missed, 62 were flown over only once before being seen visually and then extinguished.

As indicated by the following comparison between initial, in-

flight identification and post-flight analysis, there was little difficulty interpreting marks put on the image by the electronic equipment (fig. 3). Initially recorded and identified were 804 hot targets, 169 wildfires and 635 miscellaneous targets. Finally analyzed were 141 confirmed wildfires, 19 unconfirmed reports of fires, and 631 miscellaneous targets resulting in a discrepancy of only 13. (By unconfirmed, I mean no fire was found that required suppression action.)

The problem of false alarms that was so evident in the 1967 tests is solved for nighttime flights through the use of the two-detector receiver. During the high-altitude, daytime patrols, sunlight reflections are

still a concern, but these can be minimized by flying east-west instead of north-south strips.

Fire Mapping Increases

The improved infrared (IR) system was also used in 1970 to map 13 large forest fires in Montana and Idaho during all phases of suppression activity and for mopup mapping on the fires north of Wenatchee, Washington. At daylight, imagery was usually delivered by light aircraft or helicopter to the fire camps where interpretation was done by anyone who had an aerial photography background and had had a minimum of interpretation instruction.

The ability of the equipment to mark the small, hot target (the unique detection capability of the target discriminator, an instrument that *marks* fire locations on the imagery even when the fires are too small to be *printed* on the imagery) is invaluable during mop-up. Fires too small to print on the image can be identified and found by suppression crews. This provides the fire boss with information never before available for making decisions on manpower needs and placement (fig. 4).

Let Airplanes Fly More Often

Several conclusions are evident after reviewing the 1970 data: An obvious one is that the projects' operational strategy must have been in error if it did not have the airplane up over half of the fires in the area. Strategy included plans to fly the entire test area on each patrol; however, by waiting for conditions that were just right, flights were sometimes delayed or even cancelled. Thus, between flights, many fires were seen visually and extinguished. Furthermore, fire occurrence patterns indicated that it was not



Figure 3.—1970 fire detection imagery, 15,000 feet over terrain. A, marks put on by target discriminator; B, navigation marks at 1 nautical mile. There were no fires large enough to print. Target 81906 is a campfire at trail junction; 81907 is a campfire at a lake; and 81908 is a wild-fire on a southeast slope.

necessary to fly the entire area after each storm. Lower level flights over a smaller area, below the cloud cover, might be one solution.

A second conclusion is that it is difficult to compare the relative effectiveness of two systems (i.e., visual and infrared) after only one season—especially when they operate on completely different principles. The fire season in the area was not critical, although a larger than usual number of fires started. Actually, during the test of the improved infrared (IR) system we did not prevent any big fires from developing. None of the fires that were discovered by IR but not manned until several days later following visual detection, became large. On the other hand, none that were missed by IR became large. In summary, although early detection by IR can be a factor in preventing development of large fires, in this particular study such was not the case.

Fifty percent of the fires in the test area were discovered by



Figure 4.—1970 fire mapping imagery, 7,000 feet over terrain. Left-hand imagery is shown with marks put on by target discriminator (TDM) (note small targets marked do not show in imagery to right). Right-hand image is without TDM marks. Larger fires and fire perimeter are easy to see. Marks in margin at B are navigation marks 1 nautical mile apart.

visual methods within 7 hours after originating (fig. 5). This indicates that many fires became visible quite rapidly following ignition, before an IR flight could be planned and flown.

All of these lead to one final conclusion—we need to continue IR detection system tests, under operational conditions, using revised strategy in combination with strategically located lookouts and well planned visual air patrols.

IR Used

The infrared detection system is now operational. As of July 1, 1971, the Forest Service Region 1 took over the program and is flying detection patrols over the same test area flown in 1970. This time, however, there are only 33 lookouts manned and the Forests are dependent on the results of the daily flights.

FIDO (Five-Forest Infrared Detection Operation) is manned by two crews, each consisting of a pilot and interpreter-equipment operator. A unit supervisor plans and coordinates the

flights, makes sure that target information gets to the Forests, and provides general guidance and control.

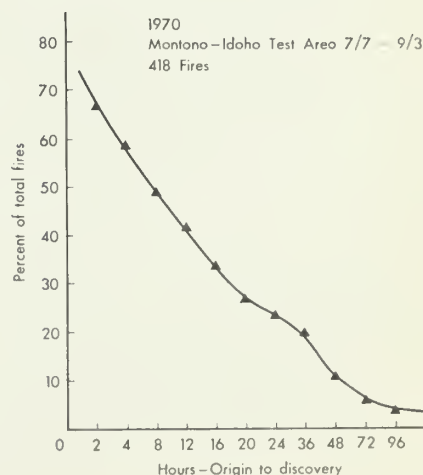
New Recorder To Help Surveillance

In the near future, we hope to have a new recorder using a 9-inch-wide, heat-developed paper that will replace the present wet-chemical processor. Nearly current imagery (real time) will be available in a continuous strip, but it will be a positive image instead of the presently used negative.

It will be a fire surveillance system capable of detecting the small latent fire and of doing the best possible job of fire mapping for precontrol planning and post-control mopup!



Figure 5.—Percent of fires remaining to be detected.



MINE, from p.10.

fissure a fire hazard. As many as six separate forest fires in one season have started this way, all from one mine fire.

Mine fires nearer the surface kill and injure trees by overheating their root zones. Gas emissions also injure trees by leaf contact. The sulfur dioxide sometimes emitted can be harmful not only to vegetation but to animals and humans as well.

Men fighting forest fires in the location of mine fires have more than the usual hazards. Many of the crevices above old works are large enough for an unsuspecting fire fighter to fall through. Even if crevices are not large enough to fall through, they may still be deadly traps that can suffocate or burn a person. Equally dangerous are old unmarked, unguarded air shafts located in many mine areas.

As a result of the fissure and shaft hazard, firelines are usually not constructed at night in mine areas. When a line must be built at night, the crews are instructed to stay at least 200 feet from the nearest known danger zone. During the day, line construction is kept at least 50 feet back from known danger zones. All fire crew leaders must be men experienced with the mine areas.

Barriers Failed

In the 1930's, W.P.A. programs combated mine fires in this area. USDI, Bureau of Mines officials, directing local labor forces, attempted to seal several underground sections of the New Straitsville mine fire. Concrete and brick barriers were constructed within the shafts. Those barriers were inserted well into the shale formation above and the clay formation below the coal vein. The fires burned through the shale and continued on.

Considerable effort was spent by local mining companies, with the Bureau of Mines, on attempts to stop coal fires on company strip mines. But fires still managed to burn.

Because nothing seemed to work, most attempts to control mine fires stopped.

Presuppression and Dozers Used

The District has six active mine fires. Each year, the sites are checked before both spring and fall fire season. The District fire control technician makes a thorough investigation to determine fire conditions. Mine fire progress is mapped and the need for presuppression action is decided. Maps showing the latest position of mine fires are used by the fire dispatcher to update his information. During critical fire danger periods, the mines are checked and reported on daily.

District crews perform presuppression work around mine sites, constructing fire breaks with dozers or hand tools. Fuels between fire breaks and mine fires are then burned. This procedure is very successful and also works with burning coal waste piles.

Another method of control has been to use heavy dozers smothering a fire in the coal vein. This can be done only where the vein outcrops in hollows or hilly terrain. Soil is pushed, mixed, and finally spread over burning coal at the outcrop. Ultimately, the fire is smothered, although it takes several years. Several mine fires on the District have been put out this way.

These methods are the only practical way the District has to stop or slow down mine fires. Nevertheless until better ways are devised, the Athens District will continue to use these methods to control mine fires. 



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OFFICIAL BUSINESS

POSTAGE
& FEES PAID
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After Initial Tests,

C-130 Hercules Flown on Romero Fire

Test and evaluation of a modular retardant dropping system in a C-130 Hercules was recently completed at Edwards AFB in California.

The dropping system consisted of five 500-gal. cylindrical tanks installed in a C-130. The tanks were valved into two 16-in. exhaust manifolds (discharge pipes), one on each side of the aircraft exiting out the troop doors. The total capacity of the system was approximately 3,000 gal., including tanks and exhaust manifolds.

The U. S. Air Force contracted the test and evaluation of the tanks. Technical guidance was furnished by the Forest Service, with actual retardant dropping conducted by the California Air

National Guard of Van Nuys, Calif. Technical assistance also was furnished by U. S. Army flight test personnel of Edwards Air Force Base.

In addition to the successful testing of the system at Edwards, the aircraft was employed for test and evaluation purposes only on the Romero Fire at Santa Barbara, Calif. in October 1971. Results of Romero Fire testing have not been published yet. (The IR scanner, featured on p. 11 of this issue of Fire Control Notes, was also used on the Romero Fire.) Δ



One of two exhaust manifolds on C-130 through which retardant is dropped (see cover photo).